



6-1936

Utilization of fruits by freezing

James Robert Kelley

Follow this and additional works at: https://trace.tennessee.edu/utk_gradthes

Recommended Citation

Kelley, James Robert, "Utilization of fruits by freezing. " Master's Thesis, University of Tennessee, 1936.
https://trace.tennessee.edu/utk_gradthes/9140

This Thesis is brought to you for free and open access by the Graduate School at TRACE: Tennessee Research and Creative Exchange. It has been accepted for inclusion in Masters Theses by an authorized administrator of TRACE: Tennessee Research and Creative Exchange. For more information, please contact trace@utk.edu.

To the Graduate Council:

I am submitting herewith a thesis written by James Robert Kelley entitled "Utilization of fruits by freezing." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

C. E. Allred, Major Professor

We have read this thesis and recommend its acceptance:

A. G. Burg

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

Color:
Blue, green
red, tan, or
yellow

May 20, 1936

To the Committee on Graduate Study:

I submit herewith a thesis written by Mr. James R. Kelley and entitled "The Utilization of Fruits by Freezing", and recommend that it be accepted for eighteen quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

L. E. Allred
Major Professor

At the request of the
Committee on Graduate Study,
we have read this thesis,
and recommend its acceptance.

J. D. Pascoe
W. B. King

Accepted by the Committee

Joseph A. Newell
Chairman

UTILIZATION OF FRUITS BY FREEZING

-0-

A THESIS

Submitted to the Graduate Committee
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

by

JAMES R. KELLEY

June 1936

CONTENTS

	Page
Introduction	1
Purpose.	1
Need for Study	1
Source of Information.	11
Chapter I. Development and Present Status of the Frozen Fruit Industry.	1
1. Introduction	1
2. Development of Refrigeration	1
3. Development of Refrigerated Transportation	3
4. Development of Methods of Cold Packing	6
a. Slow Freezing.	6
b. Current Freezing Methods	9
(1) Birdseye Method.	10
(2) Cooke Method	11
(3) Kolbe System	12
(4) The Paterson System.	12
5. Trends in the Production of Frozen Fruit	12
a. Increase in Number of Products Frozen.	12
b. Trends in Quantity	13
6. Importance and Trend of the Various Fruits Frozen.	16
7. Location of the Frozen Fruit Industry in the United States	24
a. All Fruit by States.	24
b. Frozen Strawberries.	34
c. Kinds of Fruit Packed by States.	34
8. Freezing in Tennessee.	37
9. Summary.	37
Chapter II. Need For, Advantages, and Problems of The Frozen Fruit Industry.	44
1. Introduction	44
2. Need for Additional Outlets for Fruits	44
a. Losses due to Imperfect and Decayed Fruit.	44
b. Losses due to Unharvested Fruit.	46
c. Losses to Tennessee Strawberry Growers	54
d. Tennessee Compared to Other States	57
3. Seasonal Price of Fresh Fruit a Factor in Determining the Time to Freeze	57
a. Fluctuation in Strawberry Prices	57
b. Fluctuation in Peach Prices.	65
c. Fluctuation in Price of Raspberries, Huckleberries, Blackberries, and Dewberries	81
4. Advantages of Freezing	81
a. Advantages of Frozen Food to Consumers	81

17 Oct 36 7MB . 90

CONTENTS (Continued)

	Page
b. Advantages of Freezing to the Fruit Producers.	85
c. Advantages of Frozen Food to the Ice Cream and Preserve Manufacturers, etc.	85
d. The Stabilizing Effect on Price to Producers	86
e. Effect of Freezing on Industrial Conditions.	88
5. Problems Facing the Freezing Industry.	89
a. Storage.	89
b. Feasibility of Freezing.	89
c. Competition of Frozen Fruit.	91
d. Distribution Problem	93
e. Maintaining Proper Conditions in the Freezing Process.	94
(1) Relation of Bacteria to Temperature.	95
(2) Physical and Biological Aspects.	95
6. Summary.	98
Chapter III. Cold Storage Facilities	100
1. Introduction	100
2. Proper Cold Storage Important in the Freezing Process.	100
3. The Refrigerated Warehouse Industry in the United States as a Whole	101
4. Location of Refrigerated Space in the United States.	103
a. By States or Groups of States.	103
b. In Leading Cities.	108
5. Kind of Refrigerated Space	108
a. Total United States.	108
b. Space by States.	108
6. Cold Storage Facilities in Tennessee and Surrounding States	112
a. Concerns with Refrigerating Equipment for Ice and Storage.	112
7. Freezing Storage in Tennessee.	121
8. Cold Storage Holdings of Frozen and Preserved Fruits	126
9. Summary.	132
Chapter IV. Cost of Freezing Fruit	134
1. Introduction	134
2. The Elements of Cost	134
a. Operations	134
b. Labor Costs.	136
c. Cost of Containers	137
d. Equipment Needed in Cold Packing	137
e. Cold Storage	137
3. Estimated Cost of Freezing Fruit	139
a. Cost of Freezing Experimentally.	139
b. Cost of Commercial Freezing.	140
c. Cost of Freezing Peaches	143
4. Summary.	144

CONTENTS (Continued)

Page

Chapter V.	The Marketing of Frozen Fruit	146
1.	Introduction	146
2.	Marketing Agencies	146
3.	Some Costs of Marketing Frozen Food.	148
4.	Major Consuming Markets.	151
	a. Cities Using Frozen Fruits	151
	b. Varieties of Frozen Strawberries Consumed by Cities.	153
	c. Markets for Other Frozen Fruits.	160
	d. Number Commercial Consumers by Cities.	160
5.	Types of Containers Used	160
	a. Comparative Advantage of Certain Types	165
	b. Trend in Size of Containers.	169
6.	Prices Received for Frozen Fruit	169
	a. Wholesale Prices by Kind of Fruit.	169
	b. Price by Type of Consumer and by Markets	174
	c. Prices by Type of Container.	177
	d. Retail Prices.	177
7.	Summary.	181
Bibliography.		183

FIGURES IN TEXT

	<u>Facing Page</u>
1. Quantity of Fruit Frozen 1919-1934	14
2. Comparison of the Total Farm Value of Small Fruit with Quantity Cold-Packed in United States 1925-1935	17
3. Production and Price of Fresh Strawberries Compared to Quantity Frozen in the Northwest	20
4. Percentage Distribution of Frozen Fruits by Kinds: Northwest 1934	21
5. Trend in the Cold-Packing of Specified Small Fruits in the Pacific Northwest	23
6. Quantity and Value of Fruit Cold-Packed in the Pacific Northwest	25
7. Counties Reporting Establishments Engaged in Freezing Specified Products, 1935	29
8. Production of Frozen Fruit by States or Sections	32
9. Quantities of Strawberries Frozen by States or Groups of States, 1930	35
10. Strawberries; Acreage and Production in 16 Leading Counties of Tennessee, 1935	38
11. Strawberry Yield and Amount Unharvested in 16 Leading Counties of Tennessee, 1935	39
12. Areas Freezing Fruits in Tennessee	40
13. Possible Saving to Farmer if Part of Strawberry Crop is Frozen	47
14. Estimated Quantities of Strawberries not Harvested in Various States, 1934	49
15. Strawberry Acreage in United States, 1934	51
16. Seasonal Price of Strawberries in Various Producing States	55
17. Seasonal Price of Strawberries Received by Producers by States 1934	58
18. Carlot Shipments of Strawberries by States, 1934	59

FIGURES IN TEXT (Continued)

	<u>Facing Page</u>
19. Carlot Shipments of Strawberries by State of Origin 1920-1934	61
20. Strawberries: Yield per Acre by States 1934	62
21. Average Strawberry Shipping Season by States	64
22. Daily Carlot Shipments of Strawberries in United States Compared to Price on the Cincinnati Market, 1930	66
23. Daily Price of Strawberries to East Tennessee Growers Compared to Cost of Production, 1928	69
24. Monthly Carlot Shipments of Strawberries in United States. Ave. 1925-1935	72
25. Daily Carlot Shipments of Peaches in United States Compared to Price on Cincinnati and Atlanta Markets to Jobbers, 1935	76
26. Strawberries: Carlot Shipments in the United States, 1935, Weekly Prices, and Cost of Production in Tennessee, 1935	87
27. Total Refrigerated Space by States, 1933	104
28. Cold Storage Space in United States at 10° F. and Below, 1929	113
29. Number of Concerns Operating Ice Factories and Cold Storage Houses in Tennessee, 1935	121
30. Refrigerated Warehouses in Tennessee and Surrounding States, 1935	122
31. Cold Storage Holdings of Preserved and Frozen Fruits by Sections, 1933	127
32. Cold Storage Holdings of Frozen Fruit 1928-1936	130
33. Channels of Marketing Frozen Fruit	149
34. Production, and Consumption of Frozen Strawberries, 1935	152
35. Cold Pack Strawberries Packed in 450 Lb. Barrels. Consumed by Preserve Manufacturers, by Cities, 1935	154

FIGURES IN TEXT (Continued)

	<u>Facing Page</u>
36. Cold Pack Strawberries Packed in 450 Lb. Barrels. Consumed by Ice Cream Manufacturers, by Cities, 1935	155
37. Source, Distribution, and Consumption of Cold-Pack Marshall Strawberries, 1935	156
38. Source, Distribution, and Consumption of Cold-Pack Klondyke Strawberries Packed in 450 Lb. Barrels, 1935	157
39. Source, Distribution, and Consumption of Cold-Pack Missionary Strawberries Packed in 450 Lb. Barrels	158
40. Source, Distribution, and Consumption of Cold-Pack Blakemore Strawberries Packed in 450 Lb. Barrels	159
41. Source, Distribution, and Consumption of Cold-Pack Red Raspberries, 1935	161
42. Source, Distribution, and Consumption of Cold-Pack Blackberries, 1935	162
43. Source, Distribution, and Consumption of Cold-Pack Blueberries, 1935	163

TABLES IN TEXT

	<u>Page</u>
I Production of Frozen Fruit in the United States, 1918-35	15
II Strawberry Production in the United States	18
III Gross Income from Small Fruits in United States, 1924-33	19
IV Quantities of Frozen Fruits Produced in Oregon and Washington	22
V Total Production and Value of Western Frozen Fruits, 1932-34	26
VI "Frozen-Pack" in the Pacific Northwest	27
VII Towns and Counties Reported as Freezing Fruits, Vegetables, or Fruit Juices by Slow or Quick-Freezing Methods, 1935	30
VIII Concerns Doing Quick-Freezing in the United States, 1931	31
IX Production of Frozen Fruit by Sections	33
X Producing Areas of Frozen Strawberries	36
XI Strawberry Production in 16 Leading Tennessee Counties, 1935	41
XII Extent and Causes of Losses to Consumers of Specified Fruits and Vegetables in an Eastern City, 1935	46
XIII Quantities of Strawberries not Harvested	50
XIV Strawberries: Commercial Crop, Acreage, and Production, 1933-35	52
XV Peaches not Harvested on Account of Market Conditions	53
XVI Seasonal Farm Price for Strawberries, 1926-35	56
XVII Strawberry Carlot Shipments by State of Origin, 1920-35	60
XVIII Strawberry Shipping Season of States 1926-1930 Average	63
XIX Carlot Shipments of Strawberries in United States, 1929-30 Season	67
XX Daily Price on Cincinnati Market to Jobbers for Strawberries, 1930	68

TABLES IN TEXT (Continued)

		<u>Page</u>
XXI	Prices Paid to East Tennessee Growers for Strawberries by Grade and Variety on Designated Days, 1928	70
XXII	Cost of Producing Strawberries	71
XXIII	Daily Price of Strawberries to Jobbers on Cincinnati Market, 1935	73
XXIV	Daily Price of Strawberries to Jobbers on Atlanta Produce Market, 1935	74
XXV	The Seasonal Shipment of Strawberries in the United States (1925-1935)	75
XXVI	Daily Carlot Shipments, Peaches, United States, 1935	77
XXVII	Daily Price of Peaches on Cincinnati Market to Jobbers, 1935	78
XXVIII	Daily Price of Peaches on Atlanta Produce Market to Jobbers, 1935	79
XXIX	Daily Price of Fruits to Jobbers, Cincinnati, 1935	82
XXX	Weekly Carlot Shipments of Blackberries, Dewberries, and Loganberries in the United States, 1935	84
XXXI	Unloads of Certain Fruits and Vegetables in 66 Cities in the United States 1933	92
XXXII	Total Refrigerated Warehouse Space and Number of Concerns, United States, 1921-33	102
XXXIIa	Percentage Distribution of Total Refrigerated Warehouse Space by Regions in the United States, 1929	103
XXXIII	Total Refrigerated Space in the United States, by States	105
XXXIV	Concerns - Operating Refrigerated Warehouses, by States 1925-35	106
XXXV	Refrigerated Space: Leading Cities, all Cold Storage and Meat-Packing Establishments, Oct. 1, 1933	109
XXXVI	Refrigerated Space: Leading Cities, Public Cold Storages, Oct. 1, 1933	110
XXXVII	Change in Refrigerated Space Held at Different Temperatures in United States, 1925-33	111

TABLES IN TEXT (Continued)

		<u>Page</u>
XXXVIII	Percent of Refrigerated Space Held at Freezing and at Higher Temperatures, 1929	112
XXXIX	Total Refrigerated Space: All Cold Storages, by States, Oct. 1, 1929	114
XL	Total Refrigerated Space: All Cold Storages, by States, Oct. 1, 1933	116
XLI	Location of Concerns Operating Ice Houses, and Cold Storage Warehouses in Tennessee 1935	117
XLII	Concerns Operating Ice Houses; Cold Storage Warehouses, etc., in Tennessee, 1935	123
XLIII	Refrigerated Space in Tennessee--Summary by Class of Business 1931	125
XLIV	Refrigerated Space in Tennessee at 10° F and Below	128
XLV	Cold-Storage Stocks of Commodities on the First of Heaviest Holdings by Geographical Divisions, 1933	129
XLVI	Cold-Storage Stocks by Geographical Divisions, 1929	131
XLVII	Cold-Storage Holdings of Frozen and Preserved Fruits, 1925-35	136
XLVIII	Average Wage Paid to Hired Farm Labor--July, 1933, 1934, and 1935	138
XLIX	Freezing Storage Rates in Tennessee, 1935	138
L	Storage Rates in Various Cities, 1935	
LI	Cost of Freezing Strawberries Experimentally	139
LII	Cost of Freezing Peaches Experimentally	140
LIII	Estimated Cost of Freezing Strawberries in One-Pound Fiber Cartons	141
LIV	Estimated Cost of Freezing Strawberries on a Commercial Basis	141
LV	Estimated Cost of Cold-Packing in West Tennessee	142
LVI	Estimated Cost of Cold-Packed Fruit at Waynesville, North Carolina	143

TABLES IN TEXT (Continued)

	<u>Page</u>	
LVII	Estimated Cost of Freezing Peaches	144
LVIII	Standard Refrigerated Charges on Cold-Pack Berries, 1935	150
LIX	Number of Concerns in Specified Cities Using or Handling Frozen Fruit, 1935	164
LX	Pacific Northwest Frozen Berries and Fruits 1926-33 by Size of Containers	166
LXI	Net Weights of Barrels, Cans, and Paper Cups of Frozen Fruit	167
LXII	Pacific Northwest Frozen Pack 1926-33, by Kind of Fruit and Size of Containers	170
LXIII	Pacific Northwest Frozen Strawberry Production by Size of Containers 1927-34	173
LXIV	Average Opening Prices on the Northwest Frozen Pack Fruits 1927-31	174
LXV	Opening Prices on Northwest Frozen Pack Fruits by Size of Containers and by Pack 1932-34	175
LXVI	Prices Paid by Processors for Frozen Strawberries in Specified Cities, 1935	176
LXVII	Average Prices of Frozen Strawberries in Various Markets by Type of Containers 1935	178
LXVIII	Spot Prices of Certain Frozen Fruits F. O. B. Knoxville, 1935	179
LXIX	Prices of Frozen Foods Quoted by Birdseye Foods Corporation, September 1935	179

INTRODUCTION

Purpose

The purpose of this study is to determine (1) the development and present extent of the frozen fruit industry in the United States; (2) the available markets and marketing methods and channels; and (3) the possibilities for expansion, particularly in Tennessee. In the latter connection, special emphasis is placed on the economic advantages and disadvantages of freezing fruit to farmers and consumers, and on the cost of freezing and marketing the frozen product.

Need for Study

There is a need for some method of utilizing surplus fruits, and thus add greater stability to the price of fresh fruit. During the past four or five years there has been a steady complaint from fruit and vegetable growers about the low prices received for their products. This has been particularly true of strawberry and peach growers. The average price received for fresh strawberries in certain sections of the country has been so low during the past few years that many growers have been forced out of business. For example, in Bradley County, Tennessee, the commercial acreage of strawberries has decreased from 300 in 1930 and 1931 to 50 in 1935. Similar conditions exist in many sections of the United States. The general trend in the production of strawberries has been downward since 1928. Since 1930 the prices received by growers for strawberries have often dropped below the average cost of production. While these low prices have been due

in a large part to the low purchasing power of consumers during the depression, the utilization of a part of the crop as frozen fruit should have a beneficial effect on price.

In some sections of the United States, particularly the Pacific Northwest, freezing has proven to be a very successful method of marketing certain fruits, and it offers some possibilities in other sections of the country. In the northwest, this method of marketing affords a large outlet for small fruits during seasons of over-production. At the same time it makes a greater variety of fruits available for consumption during seasons of no production.

Source of Information

The assembling of information already available, and the supplementing of this with new information is the basis of this work. The information presented in this report was obtained from the following sources:

- (1) Bureau of the Census
- (2) United States Department of Agriculture's yearbooks; statistical bulletins; daily, weekly, and monthly reports of production, markets, shipments, and prices
- (3) The State departments of agricultural economics and statistics
- (4) Correspondence with investigators, dealers, and consumers
- (5) Questionnaires to growers, county agents, and shippers
- (6) Personal interviews with consumers, processors, managers of cold storage concerns, etc.
- (7) Railway companies for freight and refrigeration rates
- (8) Periodicals
- (9) Special market survey by the Tennessee Agricultural Experiment Station

CHAPTER I

DEVELOPMENT AND PRESENT STATUS
OF THE FROZEN FRUIT INDUSTRYIntroduction

This chapter deals primarily with the progress made in the use of mechanical refrigeration as related to the distribution and preservation of highly perishable fruits. The author has not only traced the growth of the industry in this country but has also shown its present location.

Development of Refrigeration

Refrigeration is by no means a new discovery. "History shows that the ancient Egyptians knew the secret of cooling by evaporation." This ancient method is still practiced by the natives of India. The method is very crude and involves the filling of shallow porous trays with water and placing them on beds of straw and leaving them exposed to the night winds. By morning a thin film of ice is usually formed in the surface of the water.^{1/}

During the seventeenth century the "farming" of snow was started in France. In this practice farmers living near towns or villages would carry snow from the mountains during the summer and sell it in the towns. This became such a common practice that the French Government tried to license the business, but were unable to do so as the business stopped under such regulation.

Following the "farming" of snow came the storing of ice in storage houses. During the winter men would cut large blocks of ice from

^{1/} "The Romance of Ice," Household Refrigeration Bureau of the National Association of Ice Industries - Publication No. 7, 1927, p. 2-A.

the lakes and rivers and store it until warm weather.

"The first record of American delivery of ice to the home is in 1802. The first commercial shipment of natural ice from America was exported by Frederick Tudor in 1805 when a shipload was sent to Martinique, in the West Indies, to help stay the ravages of yellow fever."^{2/}

The first machine which produced ice by purely mechanical means was invented by Dr. William Cullen about 1755. However, it was not until a century later that a refrigeration machine was placed on the market commercially. Frozen meat, such as beef and mutton, was exported from Australia to England as early as 1860.^{3/}

The early success in transporting ice and meats started the great advancement in refrigeration. As fish were known to revive after being frozen, it was conceived that the cold storage of fish would retain their freshness and prevent spoiling.

"According to Mr. Haring, the first cold storage warehouse in America seems to have been constructed for the storage of fish in New York about 1865. The first refrigerator car was put into operation in 1869, and the first record of cold storage for ocean transportation was in 1879."^{4/}

By 1880 mechanical refrigeration for the preservation of perishable foods had begun to come into practical use, and by 1900 several frozen commodities had become fairly staple.

The success in storing perishables at low temperature revolutionized production and marketing. By 1922 there were 559,138,225 cubic feet of refrigerated space in the United States, and this increased to

^{2/} Household Refrigeration, op. cit., p. 2-4.

^{3/} Anderson, J. L., Communication, Storage, and Distribution in Tennessee, 1933, p. 237.

^{4/} Preserving Food-Stuffs by Quick Freezing and Refrigeration, McGraw Publishing Company, New York, N. Y., 1931

728,594,853 cubic feet by 1929. About three-fourths of the total refrigerated space in 1922 was held at 30° to 40° F., most of it being used for the storage of apples, eggs, meat, and other semi-perishable products. The use of storage at freezing temperatures was practiced quite extensively even before 1925. Freezing storage is referred to in this connection as storage at temperatures at 15° F. and lower. Among the products now stored at freezing temperatures are the following: frozen beef, pork, lamb and mutton, eggs, lard, butter, cheese, fish, poultry, fruits, and vegetables. The increase in storage at freezing temperature has been brought about largely by the development and improvement of refrigeration equipment which has made it possible to maintain low temperatures. The improvement of transportation, the increases in population, followed by an increase in the production of perishable foods, and the lack of these perishables during the winter have all been contributing factors to the increased use of freezing temperatures for the storage of perishable products for comparatively long periods.

Development of Refrigerated Transportation

During the early development of the strawberry industry, most commercial plantings were located near the cities and towns where the fruit could be hauled to markets by the growers. However, as population increased, producing areas began to increase in number and spread in area. As the distance increased from the producing areas to the consuming centers, so did the transportation problem increase.

Before refrigerated cars were introduced, strawberries were usually shipped in what was known as ventilator cars. The great difficulty with this method of shipment was in holding the berries long enough to

make a sale. It happened very often that certain berries could not be held on the central market in good condition even for one day. Since there was no way of checking decay and bacterial development in the fruit, great losses often occurred before they reached the consuming market. These great losses discouraged growers located at points of considerable distance from the markets and were largely responsible for a decided decrease in strawberry plantings during this period.^{5/}

The transportation of strawberries by rail began as early as 1847, according to The Horticulturist. One of the first records of rail shipments was a train on the Erie Railroad which carried 26,667 quarts of strawberries into New York City.^{6/}

The Pennsylvania Railway in 1857 began their research work on the development of a refrigerated car. "In 1866 Parker Earle of Cobden, Illinois, at that time a leading strawberry grower, built twelve refrigerator chests for express shipments of strawberries." In these chests both strawberries and ice were placed. High express rates, however, killed this business.^{7/}

By 1868, D. W. Davis had patented an improved type of refrigerated car.^{7/} This car was one of the most widely used of the early refrigerator cars. It was cooled by the use of ice and salt placed in tanks at each end of the car. The first shipment of strawberries in the refrigerator car, introduced by Mr. Davis, was unsuccessful since part of the fruit became frozen while the balance was unequally cooled. In 1872 Parker Earle tried shipping precooled strawberries in a Tiffany refrigerator

^{5/} Allred, Hopkins, and Atkins, Some Economic Problems of Tennessee Strawberries, 1932, p. 45-6.

^{6/} Anderson, J. L., op. cit., p. 237.

^{7/} Allred, Hopkins, and Atkins, op. cit., p. 45-6.

car, using 3000 pounds of ice per car. This car had a V-shaped ice box hanging from the roof of the car. These berries were shipped from Cobden, Illinois to Chicago. They arrived in excellent condition. Soon after this fruit was shipped successfully to Chicago from Mississippi, Georgia, Florida, and even from California. It was not long until cars were introduced which would permit the cooling of fruit during transit. From this time (1880) up until the past two years the use of refrigerated cars has grown very rapidly. It was estimated that approximately 40,741 refrigerator cars were in use December 31, 1929.^{8/}

Refrigerated transportation is especially important to the freezing industry. For long distances, frozen foods must be transported at temperatures low enough to prevent thawing. Various methods have been used in the transportation of frozen foods. The use of ice and salt, dry ice, mechanical refrigeration, silica gel, and other methods have been tried. Ice and salt has been used mostly where icing does not have to be done too often during transit. However, where ice and salt is used uniform temperatures at 0° to 10° F. are difficult to maintain.

One of the most promising recent refrigerants used in transporting frozen foods is "silica gel." "Silica gel" is a chemical substance, in appearance like sand, but is filled with invisible pores which under normal conditions take up moisture or gas, and when heated give them off again. The silica gel is acted upon so that gas is taken up when the car is too warm, thus cooling the car. Then the silica gel is heated causing the gas to be driven off, thus raising the temperature of the car. The temperature is kept within a small variation by this constant heating

^{8/} Allred, Hopkins, Atkins, op. cit., p. 45-6.

and cooling.^{9/} These cars are equipped with automatic controls so that a very uniform temperature can be maintained for seven or eight days. These cars can be maintained at uniform temperatures of 0° F. and below. Dry ice has been used very satisfactorily in the shipment of frozen foods. However, the method is comparatively expensive. The use of dry ice will allow the shipment of products at temperatures well below zero degrees Fahrenheit.

Refrigerated motor trucks are also being used in the distribution of frozen foods. Where only short distances of 100 to 200 miles are to be covered, no refrigeration is needed if large containers are used. However, where refrigeration is required ice and salt or "dry ice" is usually used for the refrigeration of the trucks. In some cases frozen brine is used but such practices are comparatively recent and are not common.

Development of Methods of Cold-Packing Fruits

Slow Freezing. - According to the Western Canner and Packer, H. A. Baker, Sr. is credited with having put up the first frozen-pack fruits about 1908, in Denver, Colorado. His first work consisted of tests using fruit with and without sugar. He also made tests using several varieties of strawberries. These tests proved to be very encouraging and were soon followed by other experiments. These experiments convinced him that the process of freezing fruits was worthy of commercial expansion.

In 1911 Mr. Baker succeeded in making his first commercial pack. He entered into an agreement with W. H. Paulhamus, founder and for 23 years president of Puyallup and Summer Fruit Growers Association.

^{9/} "Iceless Stoveless Car Carries Pears," Better Fruit, April, 1930.

In this case, Mr. W. H. Paulhamus furnished the berries, supplies, and a plant at Puyallup, Washington, and Mr. Baker furnished the experience, method of cold-packing, and supervision. This was the beginning of the frozen fruit industry in the United States.^{10/}

"Encouraged by his success in 1911, the following year, Mr. Baker went to the east and south, where he followed the fruits in their seasons from Tampa, Florida to Hammond, Louisiana, then to Dayton, Tennessee, next to Norfolk, Virginia, and eventually to Michigan. This procedure was repeated each year thereafter until 1917."^{11/}

The author obtained some first hand information about the method used in packing this fruit. Mr. Schields, owner of the Schields Cannery, Dayton, Tennessee, told me during one of my visits to that county that he remembered a company which had cold-packed fruit in Dayton about the time of the World War. He was not sure who had done the packing, but said the company began packing in Florida and progressed northward with the season. This company rented his cannery for about two weeks to make the "pack."

Mr. Schields did not approve entirely of the method employed in packing the fruit because packing was done without washing the fruit. According to Mr. Schields the method used in this work was somewhat as follows:

The berries were purchased from the growers as cheaply as they could be bought. They were capped at the packing plant (cannery) by Negro labor, most of which was brought in by the company doing the packing. The berries, after being capped, were put into barrels, and sugar was added. The fruit was not washed, since it was thought that water

10/ "Frozen Fruits," Western Canner and Packer, Statistical No., March, 1936, p. 178.
11/ Ibid, p. 178.

would injure the product. As soon as the barrels were filled, they were sealed and taken to the Schields Ice Company where they were held at about 40° F. until a sufficient quantity had been packed to fill a railway car. Sometimes the packed fruit would remain in this cold room for as much as 48 hours before it was shipped. Mr. Schields said that he did not know where the fruit was sent but presumed that it was shipped some place where cold storage facilities were available. He heard that these berries were used for the making of preserves.

According to the Western Canner and Packer, these early operations caused such great interest that the packing plants were often thronged with spectators.

"To confuse these watchers and discourage them from entering the business, the elder Baker or his son (H. A. Baker, Jr., now secretary and treasurer of Baker, Kelley and Company, Salem, Oregon) came forth at intervals with packages of powdered sugar, which they carefully and solemnly deposited in the barrels. When asked what they were doing, they explained that they were adding the secret, carefully-guarded preservatives, which made their business possible and which, therefore, made it impossible for anyone else to become a cold-packer."^{12/}

Immediately following the success of Mr. H. A. Baker, the fruit growers of the northwest became extremely interested in this new method of marketing strawberries. Up until this time the northwest had had much trouble in marketing their fresh berries. They were located at such a great distance from the eastern markets that freight rates and losses during transit made profits very small. Under such a condition the growers were becoming very much discouraged.

The frozen fruit industry was started primarily to satisfy the demand of ice cream manufacturers for fresh fruit the year around.^{13/}

^{12/} Western Canner and Packer, op. cit., p. 178.

^{13/} Woodroof, J. G., Preservation of Fruits by Freezing: I - Peaches. Georgia Agr. Exp. Sta. Bulletin 163, 1930, p. 4.

It seemed that the canning industry could not supply fruit of sufficiently fresh flavor to maintain the ice cream trade built up during the fresh fruit season. Freezing fruit involved the following operations:

Mature fruit of specific varieties was selected for packing. The capping of this fruit was done at the packing plant. The fruit was then washed and drained. Then it was graded for size and uniformity of color and packed in barrels, sugar being added at the rate of 1 part of sugar to 2 parts of fruit. When packed and sealed the barrels of fruit were placed in a cold room at about 0° F. to 10° F. until frozen. Then they were stored at a temperature of 10° F. to 15° F. until sold.

According to the Western Canner and Packer of March 1935, some of the pioneers of the western frozen packers were:

"Mr. H. A. Baker, Sr. and Mr. H. A. Baker, Jr.; Mr. W. H. Paulhamus; Ralf Detrick Bodle and William P. McCaffray, Seattle; R. I. MacLaughlin of Oregon and H. W. Jacobs of Utah. In the north-west, outstanding contributions have been made by H. C. Diehl and J. A. Berry of the U. S. Frozen Products Laboratory, Seattle. Others in the west who have taken prominent parts in the industry's development have been: Milo R. Daughters, now of Orange, California; James A. McConkie of American Can Company; R. A. Rudnick, formerly with Continental Can Company; Professors W. V. Cruess and E. L. Overholser, M. A. Joslyn and G. L. Marsh, all formerly of California; Professor Ernest H. Wiegand, Oregon State College; and Dr. Charles Magoon of the U. S. Department of Agriculture."^{14/}

Current Freezing Methods. - Immediately following the development of the cold-pack industry on the West Coast, great interest was aroused in the various fruit sections of the country. Much research was also done on the freezing of fruits other than strawberries. The industry grew very rapidly and it was not long until vegetables were being frozen. A. B.

^{14/} Western Canner and Packer, op. cit., p. 178.

Haslacher of San Francisco is said to have been the first man to commercially freeze vegetables.^{15/} All of this development in freezing would naturally call for more and better methods of freezing, and as a result many methods are now in use. Certain fruits, vegetables, fish and other meats often call for special freezing methods. The most rapidly growing method of rapid freezing used in preserving these products is the Rapid or Quick-Freezing and involves the use of temperatures around 40° F. and below.

Rapid freezing was initiated by and for the fisheries industries.

According to Hardmen F. Taylor:

"The problem facing the fisheries of this country before rapid freezing was developed was substantially this: Fish are highly irregular in production; they are exceedingly perishable; and the greatest demand exists during the period of lowest production. Overproduction in summer depressed prices below cost, and in winter, when prices could yield a profit, the material on which a profit might have been made was not available..... A preservative was imperatively demanded, one that would permit leveling the peaks of production and consumption from season to season without impairment of quality, and also permit the product to be distributed over the continent in good condition. Refrigeration was this preservative."^{16/}

At the present time there are four well known quick-freezing methods employed. They are the Birdseye method, the Cooke method, the Kolbe System, and the Peterson System.

Birdseye Method. - In this method the freezer is operated in a cold room at 32° F. Four endless belts are used on each machine. "There are virtually two freezers in each unit, one above the other, and the boxes of product to be frozen are placed on the lower belt of each set. These lower belts protrude about 6 feet beyond the actual freezing area to aid in loading and unloading." Actual freezing is done from both sides of the

^{15/} Western Canner and Packer, op.cit., p. 178

^{16/} Preserving Food-Stuffs by Quick Freezing and Refrigeration, op. cit., p. 60-65.

package simultaneously. Brine at minus 45° to minus 50° F. is sprayed on the reverse side of each belt where it comes in contact with the package throughout the 50-foot freezing zone. The belts are composed of monel metal or stainless steel. The lower belt is 36 inches wide and the upper 44 inches wide. The edges of the upper belt flex downward and cause the brine to flow off at both sides to one insulated tank below. This apparatus has a maximum capacity of about 1200 pounds of fish per hour for each unit.

Analysis of costs per pound are as follows:

Carton	\$0.0050 per pound
Lining Carton	0.0010
Waxed Wrapper	0.0014
Shipping (50 lb. size)	0.0044
Refrigeration	0.0075
Total	\$0.0193 per pound

Another, and more recent, development by Birdseye is the portable freezing cabinet. These cabinets can be transported fairly easily and are equipped to do rapid freezing. The product to be frozen is placed in trays which in turn are placed between cooling coils in the cabinet. Temperatures of minus 40° F. are maintained in these freezers. The product is usually frozen in about 40 to 60 minutes when placed under these conditions. This type of freezer makes it possible to follow the season of harvest, and thus operating over a longer period of time, which tends to cut down the cost of overhead.^{17/}

Cooke Method.^{18/} In this system, the product to be frozen (usually fish) is placed in large galvanized iron pans. The Cooke freezer is essentially an endless chain of heavy aluminum plates having a number of 5-inch fins on their lower side. In the freezing room, these ribs or

^{17/} Preserving Food-Stuffs by Quick Freezing and Refrigeration,
op. cit., p. 121-126.

^{18/} Ibid, p. 121-126.

fins dip into calcium chloride brine at 20° F. When the product is completely frozen, the fillets, still in the container, are raised out of the brine and moved into the outer room where they are dipped in brine, thermostatically controlled at 60° F. This operation warms the aluminum plates slightly and loosens the fillets. Then the fillet are wrapped and placed in cold storage.

The Kolbe System^{19/} The Kolbe floating pan freezer is a long shallow tank of calcium chloride brine that is kept cooled at about minus 15° F. The product is placed in galvanized steel pans 20 inches in diameter by 2-1/2 inches deep. A lid is placed on the pan and it is then slid into the brine. After freezing it is wrapped and stored.

The Petersen System^{19a/} In this system the product to be frozen is placed in flat scoop-like pans. The pans hold from 20 to 50 pounds of fish. These are of such size that they may be slipped, much like a drawer from which the back had been removed, into a rack holding a number (usually 8) of rectangular metal cans. After the fish has been placed into each can, the rack is swung through a 90° angle so that the open ends of the cans are then on top. The scoops are then pulled from the cans, and the fish, or other objects to be frozen, settle enough by their own weight to press compactly against the sides of the cans. Calcium chloride brine at a temperature of minus 25° F. to minus 30° F. circulates in the tank into which the racks are lowered by conveyors similar to those used in ice plants. Forty-five minutes is required in freezing 2-inch cakes.

Trends in the Production of Frozen Fruit

Increase in Number of Products Frozen. - At the beginning of the frozen

^{19/} Preserving Food-Stuffs by Quick Freezing and Refrigeration,
 of. cit., p. 121-126.

^{19a/} Ibid

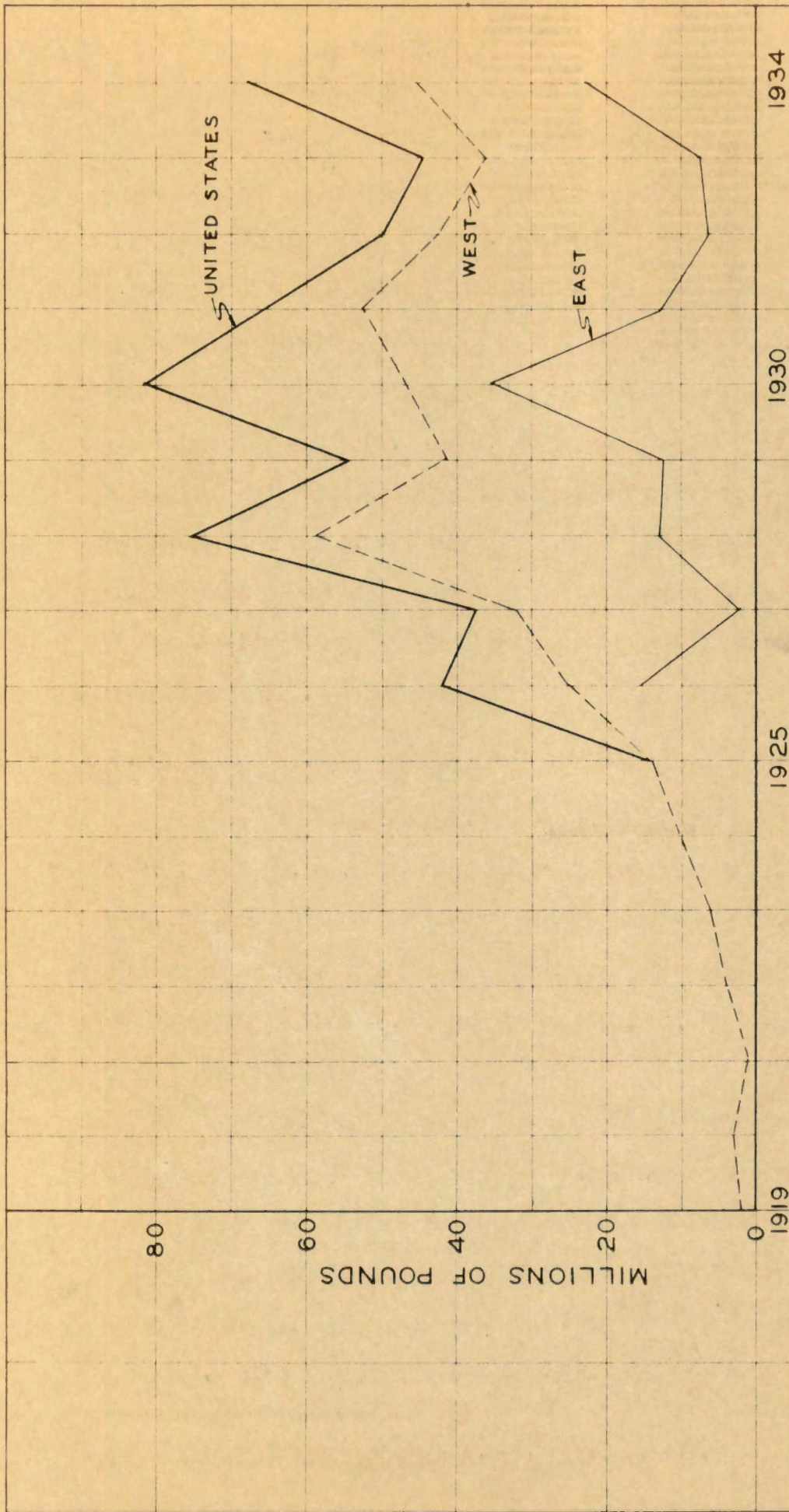
fruit industry only strawberries were frozen. Today as many as 20 different fruits are frozen, not to mention the vegetables, fish and other products. The commercial output of frozen fruits at the present time includes apricots, wild and cultivated blackberries, cherries, currants, figs, gooseberries, huckleberries, loganberries, peaches, prunes, raspberries, rhubarb, strawberries, blueberries, and youngberries. Other fruits such as cranberries, grapes, nectarines, and olives are being frozen in small quantities. Among the vegetables being cold-packed commercially one will find asparagus, broccoli, cauliflower, green corn, lima beans, peas, spinach, and snap beans.^{20/} In the line of frozen juices orange juice is rapidly becoming a popular product. As for meats, fish fillets, poultry, and special meat cuts are being frozen in relatively large quantities.

Trends in Quantity. - The freezing of strawberries in the Pacific Northwest grew by leaps and bounds. In 1918, the first year of which we have record, about 1,200,000 pounds of fruit was frozen on the West Coast. By 1928, the record year for the region, approximately 58,883,604 pounds of fruit were frozen. The largest amount of frozen fruit in the United States was recorded in 1930 with approximately 81,897,514 pounds being packed (see figure 1 and table I).

The freezing industry has had its most rapid growth since 1925 with a general trend upward until 1930, followed by a downward trend to 1933 (figure 1). In 1934 there was a marked increase over the 1933 pack.

In 1930 the eastern states froze a little more than 35 million pounds of fruit, which was more than twice the amount that they had been freezing. This sudden increase in cold-packed fruit in the eastern states

^{20/} Western Canner and Packer, op. cit., p. 178.



SOURCE: Table I

FIG. 1 - QUANTITY OF FRUIT FROZEN 1919 - 1934

TABLE I

PRODUCTION OF FROZEN FRUIT IN THE
UNITED STATES, 1918 - 1935

(Estimated to 1926)

YEAR	WEST	EAST	UNITED STATES
	<u>Pounds</u>	<u>Pounds</u>	<u>Pounds</u>
1918	1,200,000		
1919	2,000,000		
1920	3,200,000		
1921	1,200,000		
1922	4,000,000		
1923	6,000,000		
1924	10,000,000		
1925	12,000,000		12,600,000
1926	25,564,000	15,439,000	41,853,000
1927	32,456,152	2,470,000	37,326,152
1928	58,883,604	13,234,000	74,717,604
1929	41,674,513	12,631,000	54,305,513
1930	46,731,514	35,166,000	81,897,514
1931	52,462,600	13,269,000	65,731,600
1932	42,732,376	6,890,000	49,622,376
1933	36,377,767	8,044,000	44,481,767
1934	45,090,000	22,950,000	68,040,000
1935*	29,500,000*	22,500,000*	52,000,000*

* Preliminary Figures - given by prominent brokers and dealers of frozen fruit obtained by special survey.

Source: Western Canner and Packer, Stat. No., March 1935, p. 178 and 26.

might be partly explained by the widespread interest in freezing about 1929 and 1930. During 1929 and 1930 a large number of articles on freezing appeared in various magazines. Numerous lectures were also given on the subject. These things naturally created interest in freezing.

The value of frozen fruit in the west was estimated at \$3,555,635 in 1934. The output of the Pacific Northwest that year was valued at \$3,205,635. The value of strawberries increased in 1933 when production was very low. The value of blackberries increased steadily while the

quantity frozen has slightly decreased.

The amount of fruit frozen has, since 1929, followed very closely the price of fresh fruit. However, the amount packed being low when prices were low. As a general rule the total output of cold-packed fruit is directly related to production of fresh fruit (see figure 2). The gross income from all small fruits has been decreasing since 1927. The total amount cold-packed has decreased since 1930. The trend in total cold-pack has been very similar to the price received for fresh strawberries (see figure 2), and also similar to production of fresh strawberries. Whether or not there is any relation to strawberry production and the total quantity of fruit cold-packed is questionable, but trends since 1930 show some relation. This relation is probably due to the fact that nearly 60 per cent of the total amount of frozen fruit is made up of strawberries.

As most of the cold-pack fruit is frozen in the Pacific Northwest a study was made of the quantity frozen in that region with the production and price of fresh fruit (see figure 3).

Importance and Trend of the Various Frozen Fruits

In the Pacific Northwest strawberries, red raspberries, blackberries, cherries, and loganberries are the most important fruits frozen. About 58 per cent of the total cold-pack is strawberries, about 24 per cent is red raspberries, and 4 per cent is blackberries (figure 4).

Since 1928 the trend in the production of strawberries has been definitely downward (figure 5). The quantity of red raspberries cold-packed since 1928 has fluctuated widely and usually in reverse relation to the quantity of frozen strawberries. For instance, in practically every

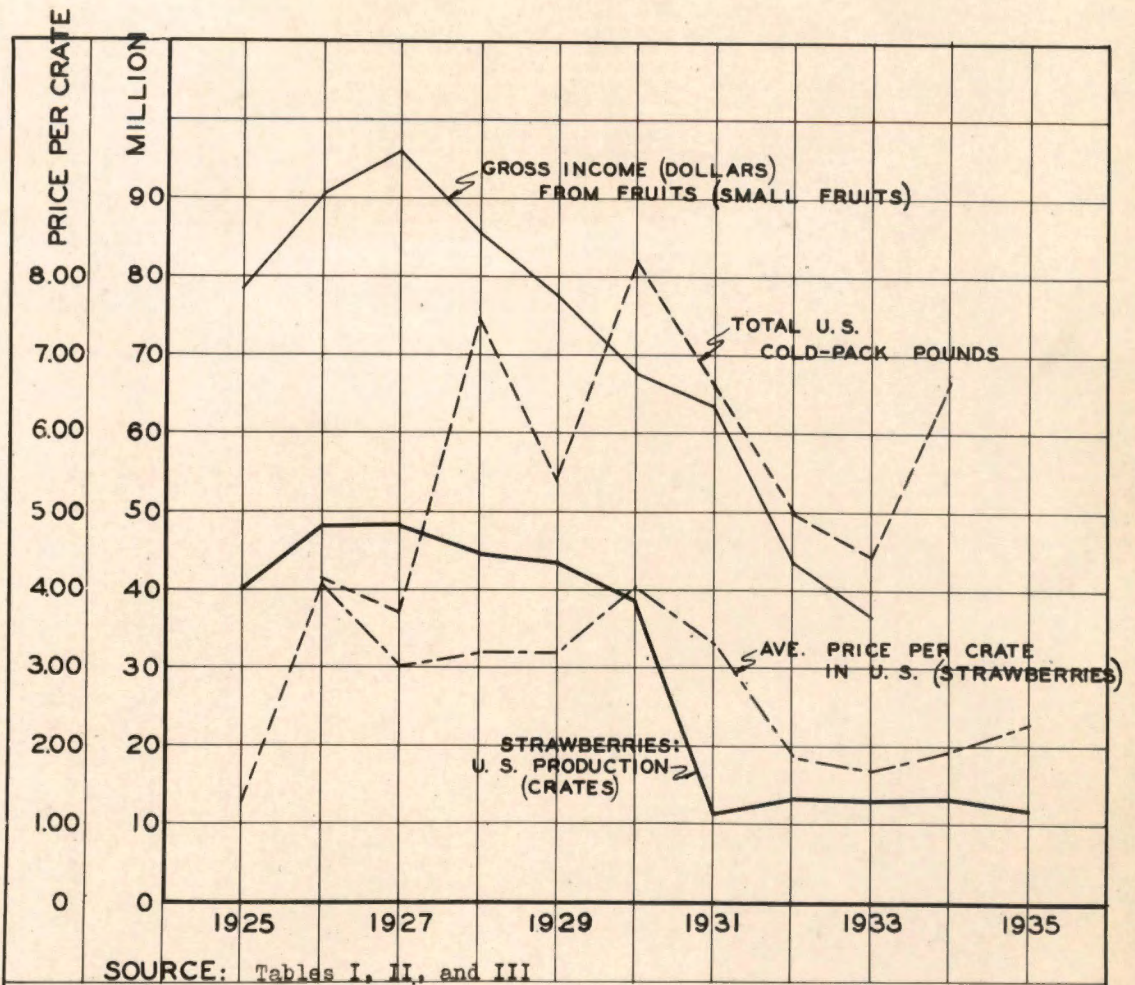


FIG. 2 - COMPARISON OF THE TOTAL FARM VALUE OF SMALL FRUIT WITH QUANTITY COLD-PACKED IN U. S. 1925 - 1935

Curves (Fig. 2) seem to indicate that the average price of fresh strawberries in the United States has a relation to the amount of fruit frozen. However, most of the cold-packing is a regional practice and would most likely be affected by the price and production in that locality where cold-packing is done. Fig. 3 shows a very close relation of production to quantity frozen in the northwest.

TABLE II

STRAWBERRY PRODUCTION IN THE UNITED STATES

	Northwest Production ^{3/}			United States ^{1/}		
	Pounds (1000 lbs) ^{4/}	Shipments Cars	Price Rec. Per Crate ^{3/}	Production (1000 Crates)	Shipments Cars	Avg. U.S. Price Rec. Per Crate
1925		99	4.80	40,623	12,256	4.08
1926		56	3.84	48,231	13,617	3.06
1927	47,178	203	2.88	48,268	17,890	3.21
1928	53,388	205	4.08	44,604 ^{2/}	18,715	3.23
1929	43,992	164	4.32	43,690 ^{2/}	18,626	4.04
1930	32,580	47	3.60	38,648 ^{2/}	10,669	3.31
1931	44,028	63	2.90	11,156 ^{2/}	13,640	1.89
1932	36,432	144	1.10	13,369 ^{2/}	13,006	1.70
1933	21,564	4	1.70	12,718 ^{2/}	13,252	1.94
1934	44,388	34	1.35	13,264 ^{2/}	13,264	
1935	46,708 *		1.70	11,681 ^{2/} *		

* 1935 preliminary figures

^{1/} Source: U. S. Agr. Yr. Book 1926-35

^{2/} Includes quantities not harvested on account of market conditions

^{3/} Northwest includes (Ore. & Wash.) price received per crate if for Washington state.

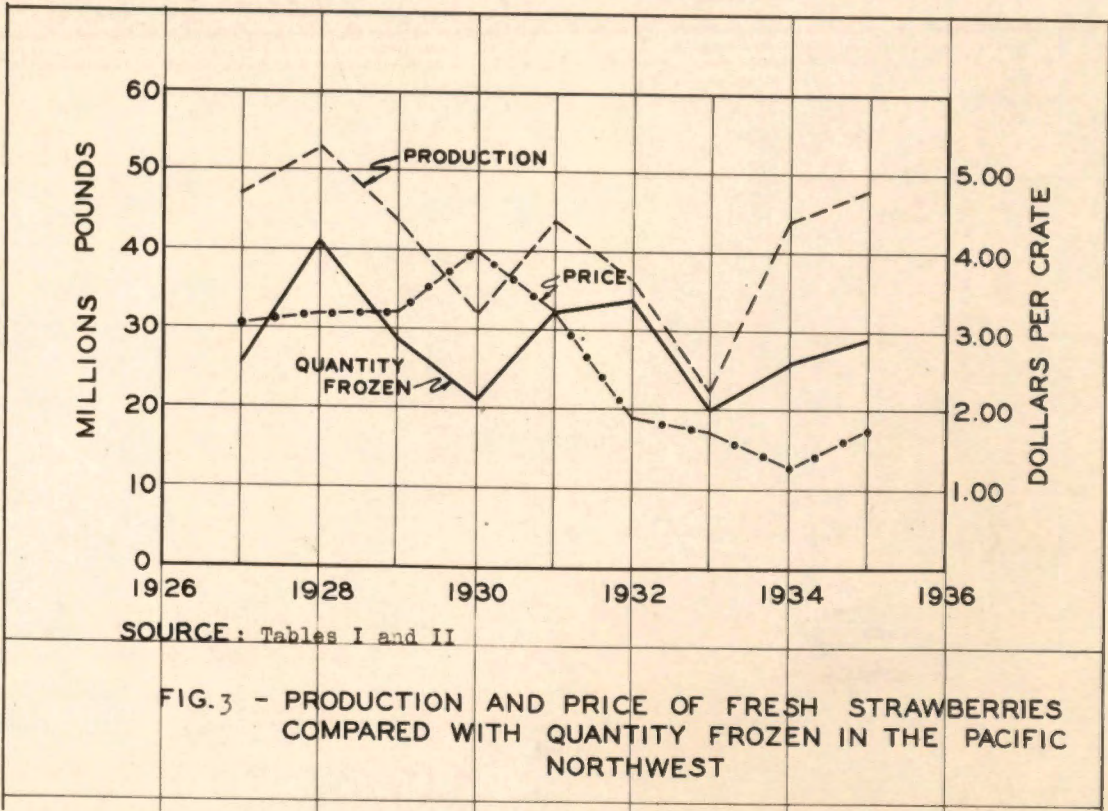
^{4/} Calculated from crates (36 lbs. per crate)

TABLE III

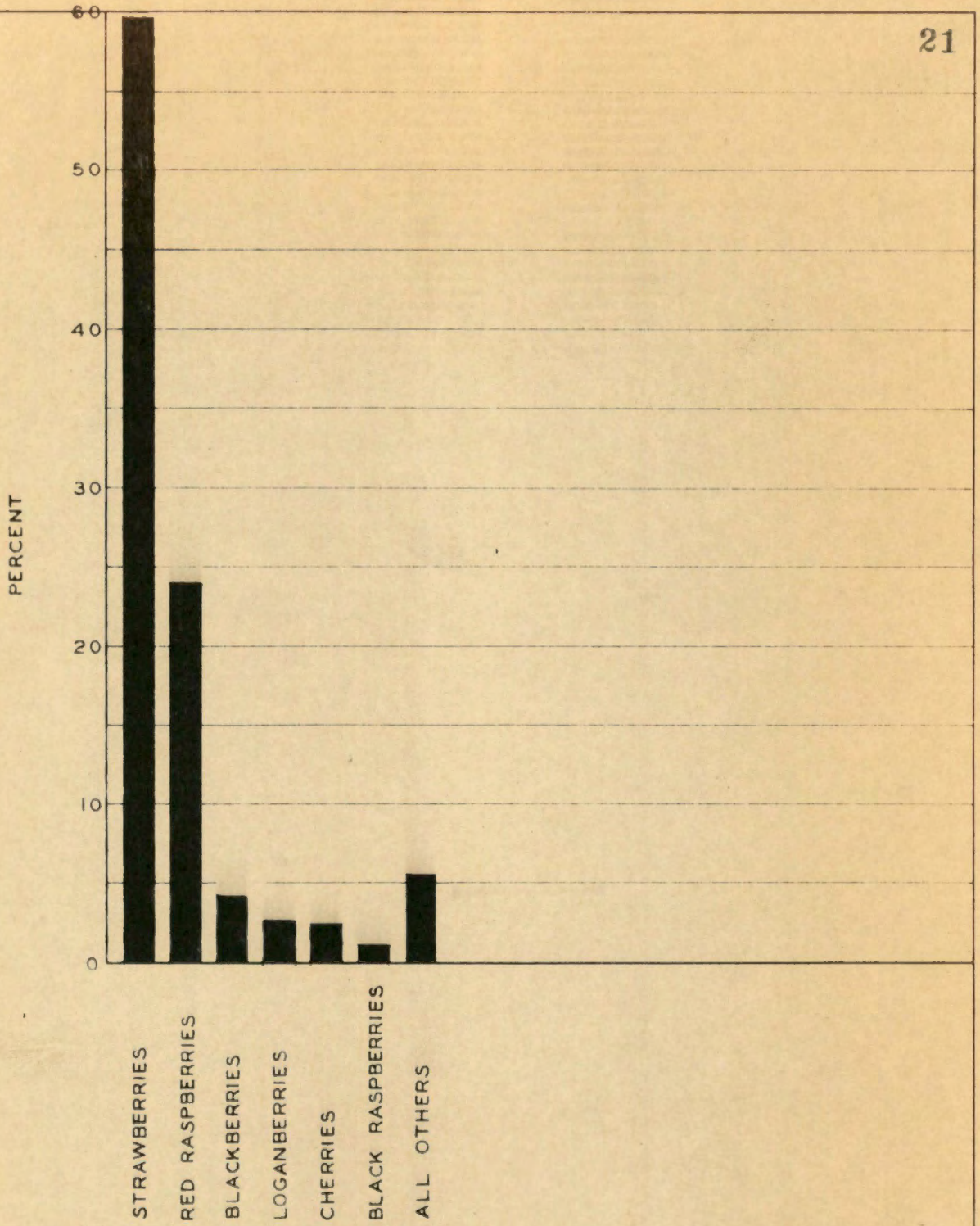
GROSS INCOME FROM SMALL FRUITS IN UNITED STATES ^{1/}

	<u>Strawberries</u> <u>1000 dollars</u>	<u>Other Small</u> <u>Fruit</u> <u>1000 dollars</u>	<u>Total</u> <u>(Small Fruits)</u> <u>1000 dollars</u>
1924	53,859	28,109	81,968
1925	50,512	28,311	78,823
1926	58,373	32,615	90,988
1927	59,179	36,857	96,036
1928	53,711	31,881	85,592
1929	54,511	23,440	77,951
1930	47,108	20,434	67,542
1931	47,280	16,171	63,451
1932	32,383	11,371	42,754
1933	27,748	9,243	36,991
1934			

^{1/} Source: U. S. Agr. Yr. Book 1926-35



Curves indicate rather clearly that the quantity of strawberries frozen in the northwest is very closely related to the production and price of fresh fruit. (Fig. 9). The quantity cold-packed in nearly every case increased with increased production. Cold-packing tended to go up where price of fruit went down, however, the price of fruit naturally changes with the production and may not have much bearing upon the quantity cold-packed. A surplus or a very large supply of fruit would tend to increase the amount cold-packed because the market demand would not be large enough to utilize all of the fresh product, and the growers would naturally resort to some other method of utilizing this excess product. Up until 1930 the quantity of strawberries cold-packed ran about opposite to price.



SOURCE: Calculated from Table IV

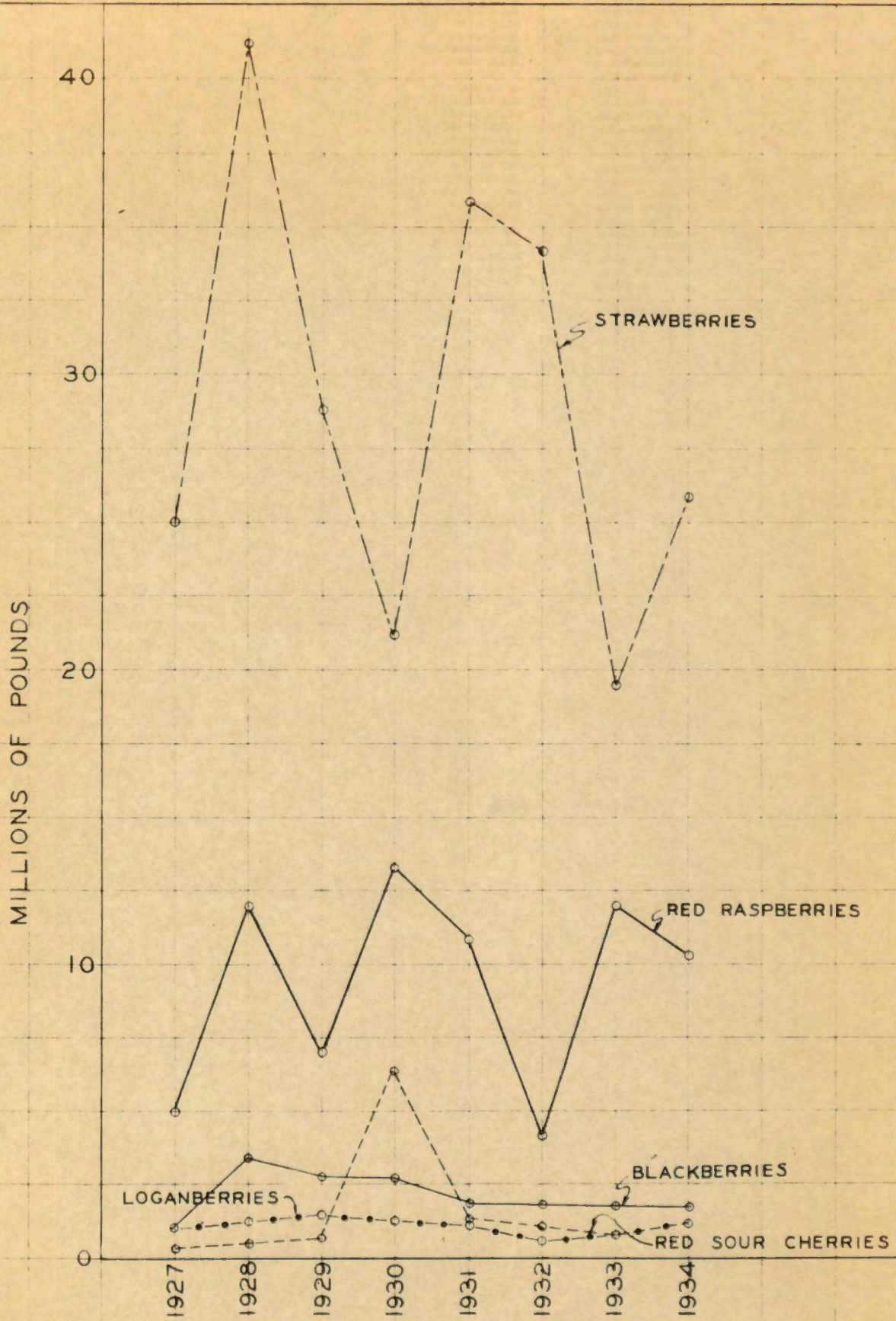
FIG. 4 - PERCENTAGE DISTRIBUTION OF FROZEN FRUITS BY KINDS: NORTHWEST 1934

TABLE IV

QUANTITIES OF FROZEN FRUITS PRODUCED IN OREGON AND WASHINGTON
(Pounds)

Food	1927	1928	1929	1930	1931	1932	1933	1934
Strawberries	25,318,476	41,209,209	28,928,282	21,497,426	35,773,000	34,075,058	19,452,899	25,788,354
Red Raspberries	4,849,075	11,904,948	7,054,059	13,277,355	10,841,000	4,140,875	12,059,062	10,384,991
Loganberries	899,935	1,158,593	1,479,421	1,224,699	1,167,000	591,686	760,816	1,205,947
Blackberries	826,671	3,347,112	2,713,387	2,756,261	1,946,000	1,858,209	1,820,610	1,778,144
Black Raspberries	140,602	496,665	487,903	1,018,154	740,000	398,834	873,490	473,258
Currants	95,070	122,327	225,700	306,020	276,000	332,892	358,975	248,400
Gooseberries	32,440	92,210	45,944	60,834	52,000	24,220	20,106	26,250
Black Cherries	--	--	12,920	--	4,600	--	6,000	--
Red Sour Cherries	266,313	376,144	513,957	6,304,154	1,353,000	1,130,023	812,340	1,065,890
Rhubarb	--	--	45,952	63,763	46,000	131,117	22,844	30,890
Pitted Prunes	--	--	6,640	56,000	--	--	4,200	--
Peaches	--	--	--	--	4,000	294	660	--
Apricots	--	--	--	--	28,000	8,978	--	10,122
Mixed Logan and Red Raspberries	--	10,800	--	--	--	--	--	--
Mixed Logan and Black Raspberries	--	55,170	--	3,960	--	--	--	--
Youngberries	--	--	--	--	--	5,090	--	--
Prunes	27,570	110,426	151,488	182,888	147,000	51,170	66,550	64,695
Huckleberries	--	--	--	--	--	--	--	900,000
Miscellaneous	--	--	--	--	--	--	--	135,292
								45,110,233

Source: Western Canner & Packer - Stat. No. Mar. 1935, P. 180



SOURCE: Table IV

FIG. 5-TREND IN THE COLD-PACKING OF SPECIFIED SMALL FRUITS IN THE PACIFIC NORTHWEST

case, the quantity of red raspberries frozen increased when the strawberry pack decreased, and vice versa. This may be due to the seasonal fluctuation, a high production of raspberries probably occurring in years of low production. There is no significant up or down trend for raspberries, and other small fruit excluding strawberries.

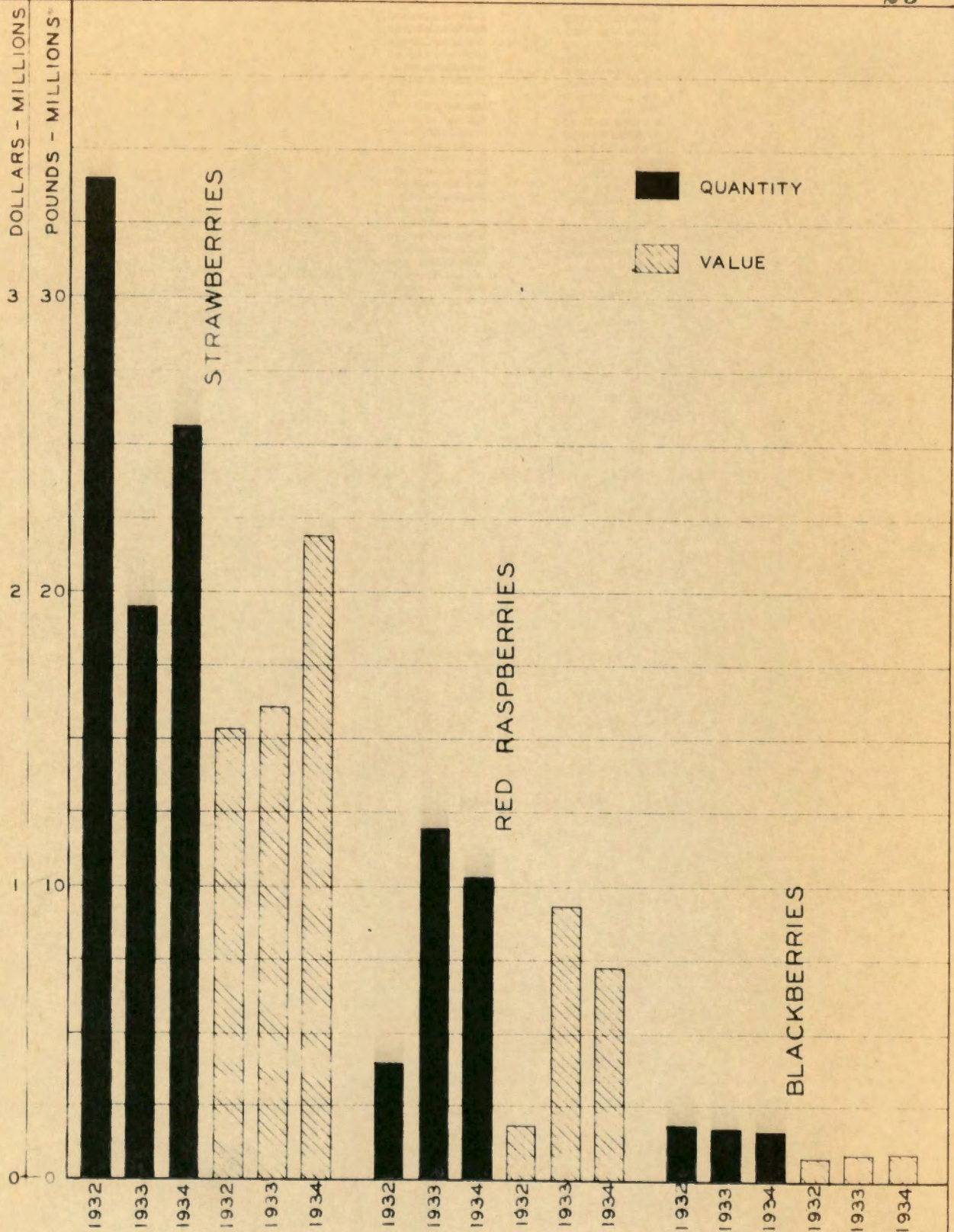
Since 1932 the value of frozen strawberries has increased every year while the trend in production has been downward (see figure 6). The value of frozen red raspberries has remained relatively the same, while the value of frozen blackberries has increased where production has decreased.

The quantity of red raspberries frozen in 1930 was about three times as great as the amount packed in 1925 (table 6). The fruits packed in 1928 in order of importance are: Strawberries, red raspberries, loganberries, raspberries other than red, black raspberries, blackberries, and cherries (table 6). In 1934 these fruits remained in the same order except blackberries had advanced above loganberries.

Location of the Frozen Fruit Industry in the United States

All Fruits by States. - At the beginning of the industry a Mr. Baker started the idea of following the fruit from the south northward as the harvest season progressed. He followed this method from 1911 until 1917, at which time he discontinued freezing east of the Mississippi River and concentrated all of his efforts in the Pacific Northwest.

The real commercial production of frozen fruits began about 1918 near Salem, Oregon. Since that time freezing has progressed until many states now freeze limited quantities of fruit commercially. Those states



SOURCE: Table V

* This weight includes sugar

FIG. 6 - QUANTITY AND VALUE OF FRUIT COLD-PACKED IN THE PACIFIC NORTHWEST

TABLE V
TOTAL PRODUCTION AND VALUE OF WESTERN FROZEN-FRUIT
1932-1934 ^{1/}

Item	1932		1933		1934	
	Pounds	Value	Pounds	Value	Pounds	Value
Strawberries	34,075,000	\$1,535,400	19,452,899	\$1,604,864	25,788,354	\$2,191,980
Red Raspberries	4,140,000	186,300	12,059,062	934,577	10,384,991	726,880
Loganberries	590,000	25,100	760,816	38,041	1,205,947	66,275
Blackberries	1,860,000	65,100	1,820,610	81,927	1,776,144	88,900
Black Raspberries	400,000	2,000	876,450	56,969	473,258	33,110
Currants	335,000	16,700	358,975	19,744	248,400	15,000
Gooseberries	25,000	1,900	20,106	1,206	26,250	1,900
Red Sour Cherries	1,120,000	56,000	812,340	44,678	1,065,890	53,630
Huckleberries	110,000	3,500	116,215	6,973	90,000	6,750
Rhubarb	15,000	700	22,844	1,371	30,890	1,610
Pitted Prunes	--	--	4,200	252	--	--
Prunes	50,000	2,000	66,550	3,993	64,695	3,000
Peaches	--	--	660	40	--	--
Apricots	10,000	600	8,978	539	10,122	800
Miscellaneous	--	--	--	--	133,292	10,800
Total N. W.	42,732,376	\$1,916,300	36,377,767	\$2,795,174	41,300,233	\$3,205,635
Utah, Colo., Cal.	4,800,000	500,000	2,000,000	324,826	2,250,000	350,000
GRAND TOTAL (West)	47,532,376	\$2,416,300	38,377,767	\$3,120,000	43,550,233	\$3,555,635

^{1/} Western Cannery & Packers - Stat. No. - Mar. 1935 - p. 30

Table V shows the value of frozen strawberries to be considerably more in 1934 than in 1932, at the same time the quantity packed was less. The tonnage of red raspberries increased nearly three times from 1932 to 1933. The quantity of frozen rhubarb has also shown a steady increase. Frozen loganberries have also been increasing in quantity.

TABLE VI
 "FROZEN PACK" IN THE PACIFIC NORTHWEST
 (Oregon - Washington)
 (Fresh fruit)

<u>Fruit</u>	<u>1925</u> <u>Tons</u>	<u>1926</u> <u>Tons</u>	<u>1927</u> <u>Tons</u>	<u>1928</u> <u>Tons</u>	<u>1929</u> <u>Tons</u>	<u>1930</u> <u>Tons</u>
Blackberries, cultivated	238	1,070	238	1,315	925	673
Blackberries, wild	755	500	169	267	434	643
Gooseberries	---	4	14	40	17	26
Loganberries	125	103	421	529	691	585
Raspberries, black	---	54	90	327	235	482
Raspberries, Cuthbert	1,141	4,531	1,333	4,940	2,820	4,932
Raspberries, other, red	664	1,103	597	420	442	731
Strawberries	3,141	5,300	11,018	14,636	10,440	7,876
Cherries, black	---	2	5	---	7	5
Cherries, Rousslet, pitted	---	---	1	---	---	132
Cherries sour, pitted	---	58	130	176	242	950
Currants	---	57	47	61	113	152
Rhubarb	---	---	---	12	18	27
Total	6,064	12,782	14,077	22,767	16,446	17,326

Source: Oregon Experiment Station Bul. 278, 1931, p. 1

now reported as freezing some fruits or vegetables for commercial purposes are Washington, Oregon, New York, Michigan, Louisiana, Wisconsin, Pennsylvania, California, Virginia, Delaware, Maryland, Tennessee, Arkansas, Florida, Alabama, Kentucky, and North Carolina, with a few being frozen in Utah, Colorado, New Jersey and Ohio.

As is shown in figure 7, the freezing industry is scattered throughout the eastern part of the United States and the Pacific Northwest, being practiced in more localities in Georgia, Tennessee, Kentucky, Ohio, Indiana, Illinois and Florida than other states. It seems that the largest packs are made in more concentrated areas where production is very heavy and where facilities are available.

Much fruit, however, is frozen annually for various purposes, for which no record is available on the location of the packer. Small preservers, ice cream manufacturers, and other small users freeze a small quantity of fruit annually to take care of their individual needs. In Tennessee nearly all large ice cream manufacturers in strawberry areas freeze some fruit in this manner. The first, and probably the most important, reason for the location of the industry in the northwest is the fact that its originator lived in the section of the country. Furthermore, large quantities of fruit were produced in that area, and markets for fresh fruit were far away. Freight costs were high making their competition with eastern fruit very difficult. The industry was developed primarily to overcome these difficulties.

When freezing first started in the northwest only "slow freezing" was practiced. Today as many as 45 towns and cities have reported freezing operations (table 7). By 1931 about 32 concerns in the United States were reported as employing quick freezing methods (table 8). Not nearly all of

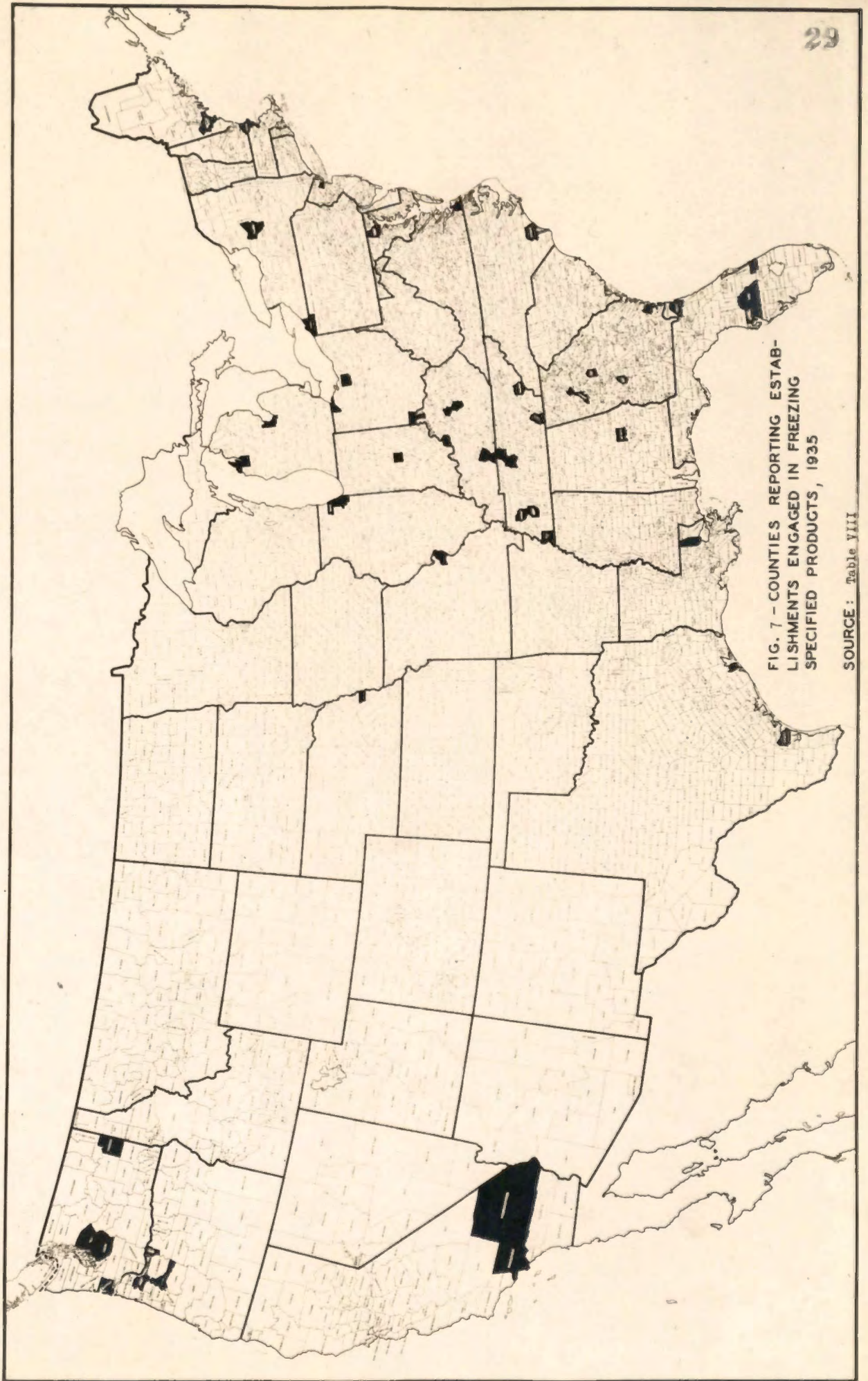


FIG. 7 - COUNTIES REPORTING ESTABLISHMENTS ENGAGED IN FREEZING SPECIFIED PRODUCTS, 1935

SOURCE: Table VII

TABLE VII

TOWNS AND COUNTIES REPORTED AS FREEZING FRUITS, VEGETABLES OR FRUIT JUICES
BY SLOW OR QUICK-FREEZING METHODS - 1935 ¹

<u>Town</u>	<u>County</u>	<u>Town</u>	<u>County</u>
1. Elmore, Ala.	Elmore	24. Hollywood, Cal.	Los Angeles
2. Tokeland, Wash.	Pacific	25. Sacramento, Cal.	Sacramento
3. Chester, Wash.	Spokane	26. Long Beach, Cal.	Los Angeles
4. Seattle, Wash.	King	27. Ontario, Cal.	San Bernardino
5. Salem, Ore.	Marion	28. Monticello, Ga.	Jasper
6. Franklin, Ky.	Simpson	29. Montezuma, Ga.	Macon
7. Bowling Green, Ky.	Warren	30. Syracuse, N. Y.	Onondago
8. Hood River, Ore.	Hood River	31. Hillsboro, Ore.	Washington
9. Omaha, Neb.	Douglas	32. Chicago, Ill.	Cook
10. New Brunswick, N. J.	Middlesex	33. Berea, Ky.	Madison
11. Covington, Ky.	Kenton	34. Louisville, Ky.	Jefferson
12. Toledo, Ohio	Lucas	35. Cincinnati, Ohio	Hamilton
13. Traverse City, Mich.	Grand Traverse	36. Jackson, Tenn.	Madison
14. Northport, Mich.	Leelanau	37. Portland, Tenn.	Sumner
15. Bellevue, Ohio	Huron	38. Humboldt, Tenn.	Gibson
16. Sturgeon Bay, Wis.	Door	39. Nashville, Tenn.	Davidson
17. Newark, N. J.	Essex	40. Maryville, Tenn.	Blount
18. Plant City, Florida	Hillsboro	41. Norfolk, Va.	Norfolk
19. Hammond, La.	Tangipahoa	42. Wilmington, N. C.	Pender
20. Tampa, Florida	Hillsboro	43. Baltimore, Md.	Independent City
21. Winter Haven, Fla.	Polk	44. Chattanooga, Tenn.	Hamilton
22. Gloucester, Mass.	Essex	45. Memphis, Tenn.	Shelby
23. Traverse City, Mich.	Grand Traverse		

¹ Source: Correspondence, Questionnaires, Market Investigation, report by Harry Carlton, Ag. Experiment Station of Tennessee, 1935 (Unpublished)

TABLE VIII

CONCERNS DOING QUICK FREEZING IN THE UNITED STATES, 1931

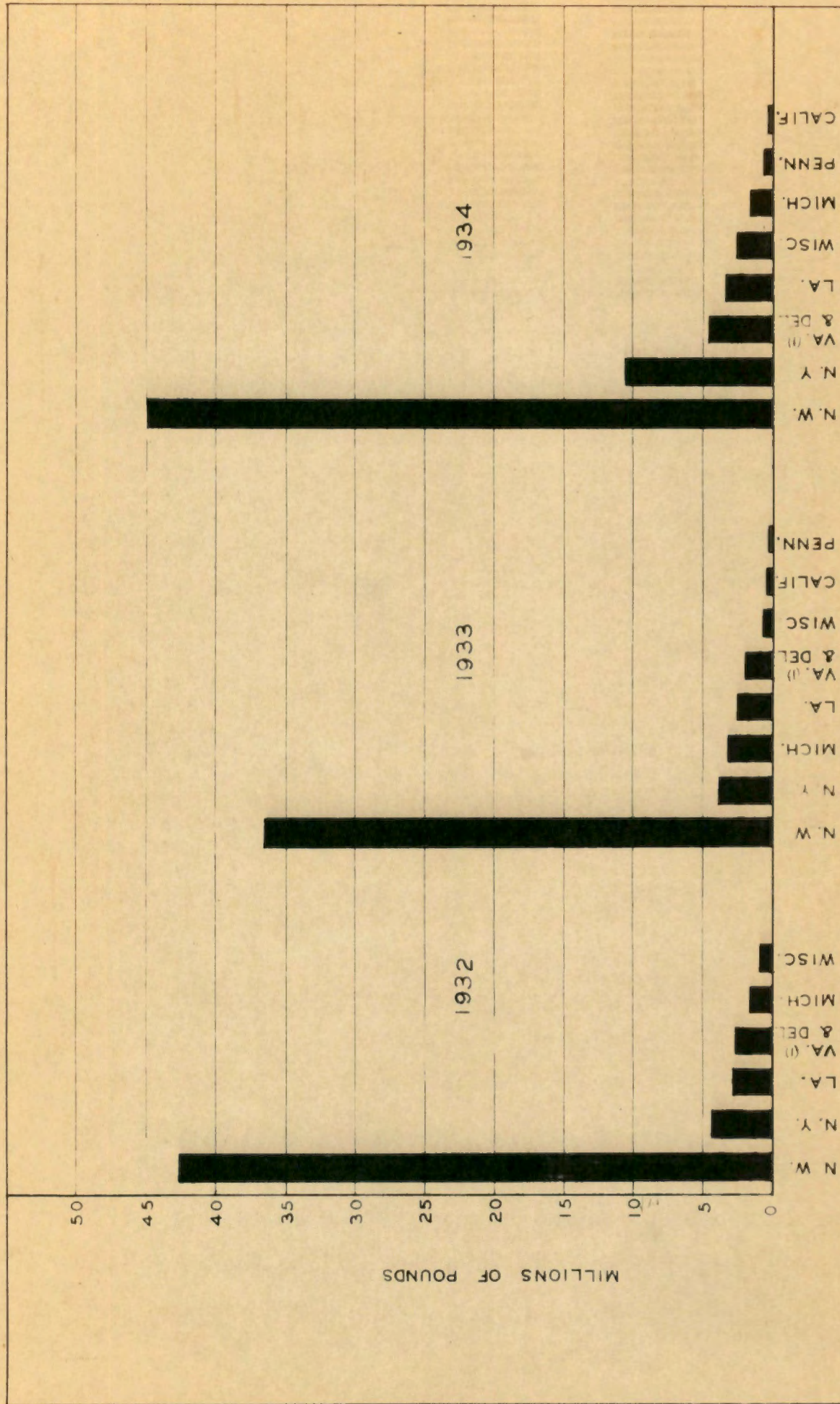
(Includes Concerns Freezing Meat, Vegetables, and Fish)

<u>Location</u>	<u>Number Concerns</u>	<u>No. Freezing Fruits, Veg. and Juice</u>	<u>Products Frozen</u>	<u>County</u>
Graton, Conn.	1		Fish & Steaks	
Tampa, Fla.	3	3	Orange Juice	Hillsboro
Jacksonville, Fla.	1		Shrimp	Duval
Winter Haven, "	1	1	Orange Juice	Polk
Sebastin, "	1		Fish	Indian River
Boston, Mass.	3		Fish	Suffolk
Gloucester, "	2	1	Fish, Fruits, Veg.	Essex
Bay City, Mich.	1		Fish	Bay
Travers City, "	1	1	Fish & Fruits	Grand Travers
Galveston, Tex.	1		Fish & Shrimp	Galveston
Corpus Christi "	1		Shrimp	Nuecus
Hollywood, Calif.	1	1	Orange Juice	Los Angeles
Sacramento, "	1	1	" "	Sacramento
Long Beach, "	1	1	" "	Los Angeles
Onterio, "	1	1	" "	San Bernardino
Portland, Me.	1		Fish	Cumberland
Omaha, Neb.	1		Meats	Douglas
Indianapolis, Ind	2		Fish & Meats	Marion
Monticello, Ga.	1	1	Peaches	Jasper
Montezuma, "	1	1	"	Macon
Brunswick, "	1		Shrimp	Glynn
Syracuse, N. Y.	1	1	Fruits & Veg.	Onodago
Erie, Pa.	1		Fish	Erie
Hillsboro, Ore.	1	1	Fruits & Veg.	Washington
Chicago, Ill.	1	1	Fruits & Meats	Cook
Total	32	15		

Source: The Preservation of Food-Stuffs by Quick Freezing and Refrigerated Methods, p. 68. Published 1931 by McGraw Hill Pub. Co.

these concerns are engaged in freezing fruits, but they might easily adapt their equipment to fruit freezing.

According to Table 9, the northwest (Oregon and Washington) packed 82% of all the frozen fruit produced in the United States in 1932. Information obtained from the market investigation made by the University of Tennessee shows that North Carolina, Florida, Arkansas, and New Jersey are



SOURCE: Table IX (1) Includes Maryland

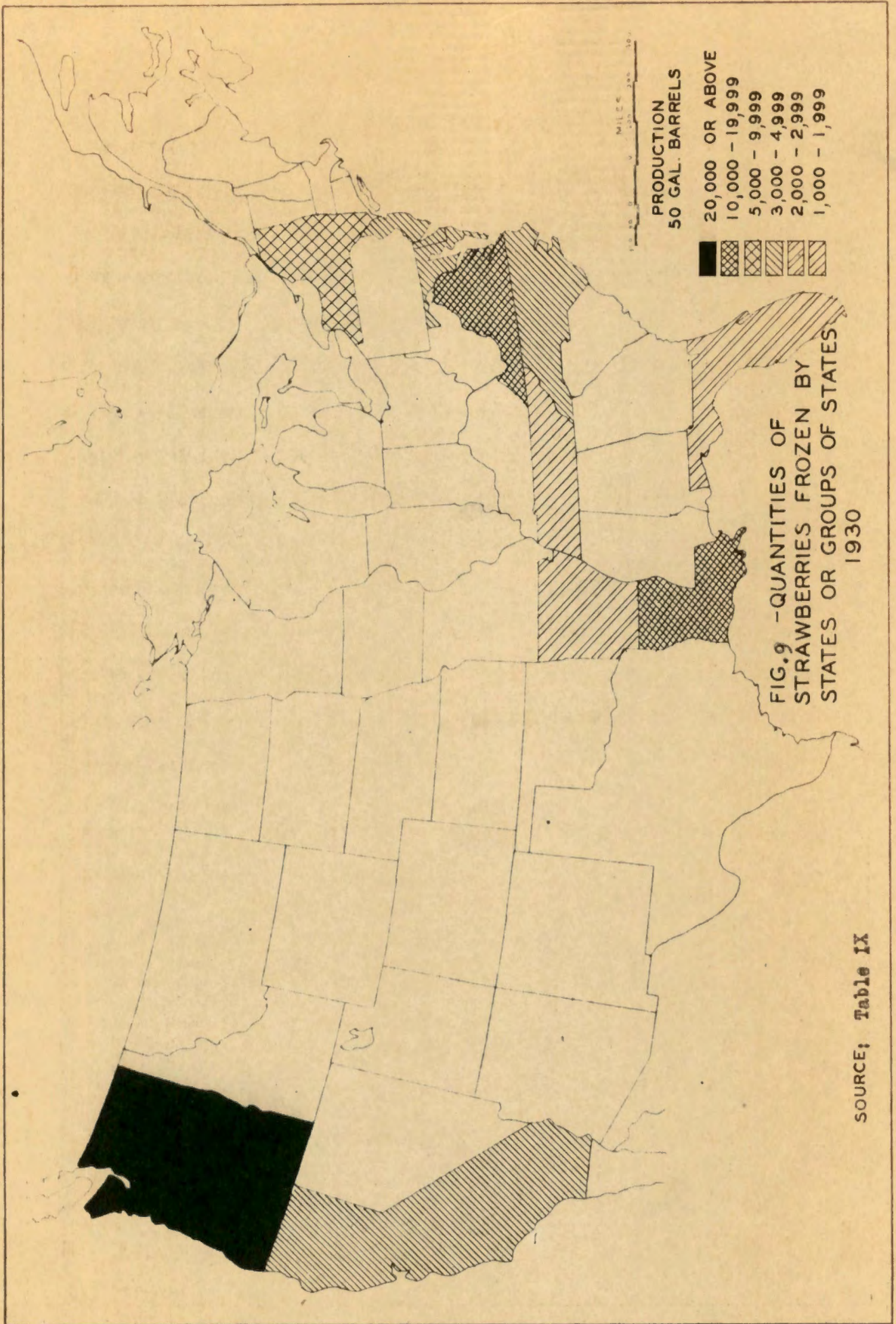
FIG. 8 - PRODUCTION OF FROZEN FRUIT BY STATES OR SECTIONS

supplying a considerable quantity of frozen fruit to the eastern markets with a very limited quantity from Tennessee.

Frozen Strawberries. - The leading states in 1930 cold-packing strawberries in importance are: Washington, Oregon, Louisiana, Virginia, Maryland, New York, Florida, North Carolina, New Jersey, California, Tennessee, Delaware, and Arkansas.^{21/} The important packing areas can be seen in figure 9. The freezing of strawberries is usually done near the areas of production. However, some packers buy surplus stock off the market in central cities for freezing purposes. Usually though the plant is located as near the growers as possible. This prevents excessive deterioration during transit from the grower to the packer. Figure 9 shows how much fruit is packed by areas. The entire area of a certain shade or color produced the amount of fruit shown in the legend. The Pacific Northwest is by far the leading region cold-packing strawberries (see figure 9). As a general rule the important strawberry producing states are those engaged in freezing.

Kinds of Fruit Packed by States. - The areas freezing fruit in the United States can almost be separated into sections packing specific fruits. In Washington and Oregon nearly all of the small fruits are frozen to a certain extent. In California freezing is confined largely to orange juice and strawberries, freezing only a few peaches and a small quantity of vegetables. In New York, Michigan, and Wisconsin most of the pack is made up of cherries, with only a few strawberries being frozen. In Ohio, Illinois, Indiana, Virginia, Tennessee, Alabama, and Louisiana strawberries are packed almost exclusively. In North Carolina and Kentucky strawberries, a good many blackberries, and a few huckleberries are frozen. In Florida

^{21/} Facts in the Food Market, November 18, 1933. P. 13.



SOURCE: Table IX

TABLE X

PRODUCING AREAS OF FROZEN STRAWBERRIES
1930 - 1935

(50 Gallon Barrels)

	1930 ⁽¹⁾	1931 ⁽¹⁾	1932 ⁽¹⁾	1933 ⁽³⁾	1934 ⁽³⁾	1935 ⁽²⁾
Pacific Northwest	49,000	77,705	68,000	39,784	45,487	40,000 to 65,000
Utah	3,315	890	1,000			
Louisiana	10,000	14,000	5,800			20,000
California	4,000	1,500	1,500			
Florida	1,200	4,000	800			
North Carolina	3,000	2,500	1,000			
Tennessee	2,500	1,000				3,000
Arkansas	1,200	600				5,000
Virginia	12,000	8,500	3,500			
Maryland	4,000	6,000	2,000			
Delaware	4,500	1,000	600			1,000
New Jersey	3,500	2,000	1,200			
New York	5,600	5,250	1,000			1,000
Maryland, Virginia and Carolinas						20,000

Source: Facts in the Food Markets, November 18, 1933, p. 13.

- (1) These figures for 1930, 1931, and 1932 given by Facts in the Food Markets do not exactly agree with figures given in Western Canner and Packer, March, 1935.
- (2) Estimates from brokers and dealers of U. S.
- (3) Western Canner and Packer, Stat. No., March, 1935

the pack is confined mostly to orange juice. Strawberries are not frozen to a very great extent in this state because their fresh fruit brings relatively high prices, as they are sold during January, February, March, and part of April when competition is low. At the present some vegetables are being frozen in New Jersey and Virginia. Most of the freezing operations in Georgia are confined to the packing of peaches (pulped for ice cream and brandy manufacture). Packing, however, is not done on a very large scale in this state.

Freezing in Tennessee

Strawberries have been frozen in Tennessee since 1920. However, during this early period it was not practiced regularly.

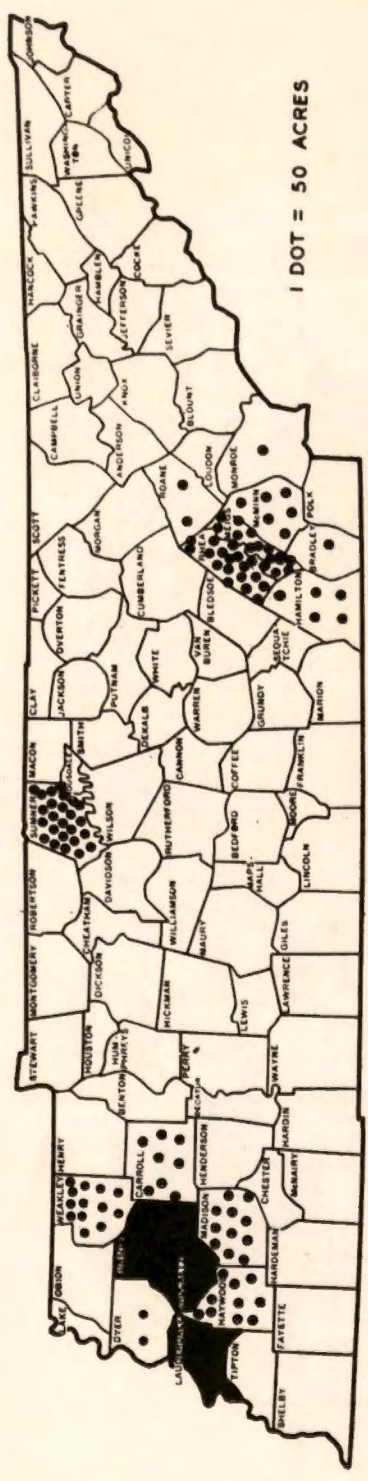
In discussing the freezing of fruit in Tennessee it is well to keep in mind the location of producing areas. The strawberry acreage, yield, and total production by counties for 1935 was obtained from questionnaires sent to the county agents of 16 leading strawberry producing counties in Tennessee. These figures can be seen in Table XI.

The areas producing strawberries are located in East, Middle, and West Tennessee (See figures 10 and 11). The areas freezing fruit in Tennessee are those producing fruit (See figure 12). The counties reporting some freezing in Tennessee are: Knox, Blount, Rhea, Hamilton, and Bradley of East Tennessee; Sumner and Davidson in Middle Tennessee; and Gibson, Carroll, Madison, and Shelby of West Tennessee. Now these counties may not freeze fruit every year, but it is a usual practice to freeze at least some for local use for ice cream manufacture. Too, the fruit is usually packed and hauled to the nearest cold storage house. Cold storage is available in Knoxville, Chattanooga, Nashville, and Memphis.

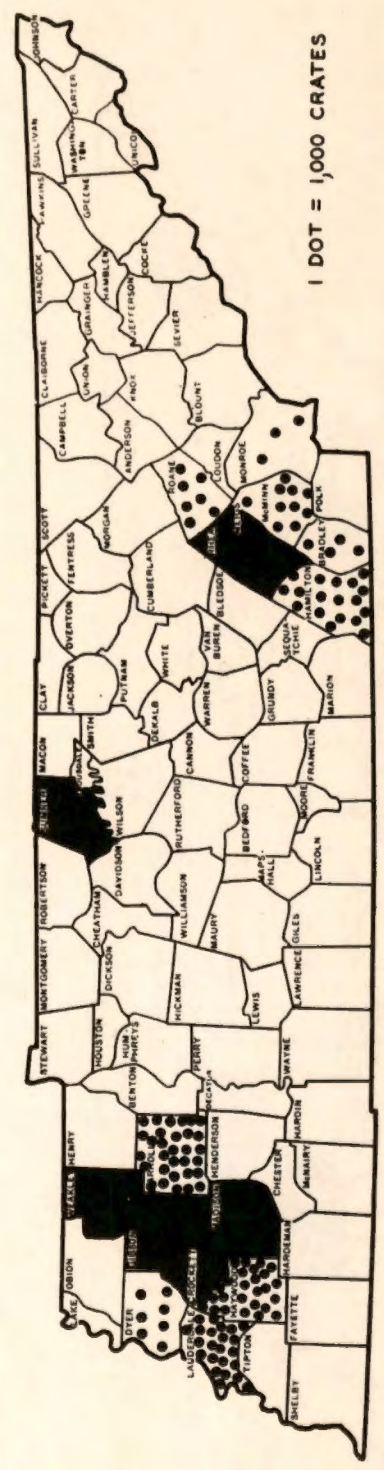
Strawberries are usually packed commercially at Humboldt, Portland, Jackson, and occasionally at Maryville and Nashville, Tennessee.

Summary

The early Egyptians knew the secret of cooling by evaporation. The farming of snow off the mountains in France was common in the seventeenth century. Following the farming of snow came the storing of ice during the winter. In 1755 the first refrigeration machine was invented. By 1865 fish were stored in cold storage houses for seasons when no fish



ACREAGE



PRODUCTION

FIG. 10 - STRAWBERRIES: ACREAGE AND PRODUCTION IN 16 LEADING COUNTIES OF TENNESSEE, 1935

Source: Table XI

TABLE XI

STRAWBERRY PRODUCTION IN 16 LEADING TENNESSEE COUNTIES - 1935 ^{1/}

County & Variety	Acres	Crates Produced	Yield Per Acre (Lbs.) ^{2/}	Crates Not Harvested (Number)	Per Cent of Production Not Harvested	Per Cent Of Acreage This Variety	Per Cent Production This Variety	Index of Yield Per Acre	Method of Shipment ^{3/}
Bradley	27	2,800	3,733	---	---	---	---	103.6	100% by truck
Aroma	15	1,500	3,600	---	---	55.5	53.5	100.0	100% by truck
Blakemore	12	1,300	3,900	---	---	45.5	46.4	108.3	100% by truck
Carroll	405	31,700	2,817	6,200	19.5	1.2	2.2	78.2	50% by truck
Aroma	5	700	5,040	200	28.6	98.7	97.7	140.0	50% by truck
Klondyke	400	31,000	2,780	6,000	19.30	---	---	77.2	50% by truck
Crockett	800	59,500	2,677	2,000	3.36	6.2	8.4	74.3	40% by truck
Blakemore	50	5,000	3,600	---	---	93.8	91.6	100.0	40% by truck
Klondyke	750	54,500	2,620	2,000	3.6	---	---	72.7	40% by truck
Dyer	100	6,800	2,448	1,050	15.4	15.0	14.7	68.0	75% by truck
Aroma	15	1,000	2,400	250	25.0	10.0	11.7	66.0	75% by truck
Blakemore	10	800	2,880	300	37.5	75.0	73.5	80.0	75% by truck
Klondyke	75	5,000	2,400	500	10.0	---	---	66.0	75% by truck
Gibson	2,000	160,150	2,882	5,150	3.2	15.0	29.03	80.0	25% by truck
Blakemore	300	46,500	5,580	1,500	3.2	75.0	62.40	155.0	25% by truck
Klondyke	1,500	100,000	2,400	3,000	3.0	10.0	8.50	66.0	25% by truck
Other (Unknown)	200	13,650	2,450	650	4.7	---	---	68.0	25% by truck
Hamilton	256	18,475	2,597	2,145	11.61	25.0	29.5	72.1	50% by truck
Aroma	64	5,465	3,073	405	7.41	43.7	43.8	85.3	50% by truck
Blakemore	112	8,110	2,605	1,190	14.60	29.2	25.0	72.3	50% by truck
Klondyke	75	4,625	2,220	525	11.30	1.9	1.48	61.6	50% by truck
Missionary	5	275	1,980	25	9.09	---	---	55.0	50% by truck
Haywood	500	25,000	1,800	5,000	20.0	40.0	40.0	50.0	96% by truck
Blakemore	200	10,000	1,800	2,000	20.0	60.0	60.0	50.0	96% by truck
Klondyke	300	15,000	1,800	3,000	20.0	---	---	50.0	96% by truck

TABLE XI (Cont'd.)

STRAWBERRY PRODUCTION IN 16 LEADING TENNESSEE COUNTIES - 1935 ^{1/}

County & Variety	Acres	Crates Produced	Yield Per Acre (Lbs.) ^{2/}	Crates Not Harvested (Number)	Per Cent of Production Not Harvested	Per Cent Of Acreage This Variety	Per Cent Production This Variety	Index of Yield Per Acre ^{3/}	Method of Shipments
Leauderdale	1,967	24,220	443	1,860	7.6			12.3	50-55% by truck
Aroma	112	1,728	555	160	9.2	5.6	7.13	15.4	
Blakemore	125	1,950	560	200	10.2	6.3	8.06	15.5	
Klondyke	1,730	20,542	427	1,500	5.9	87.9	84.80	11.8	
Madison	552	50,250	3,277	10,050	20.0			91.0	20% by truck
Blakemore	250	25,000	3,600	5,000	20.0	45.2	49.7	100.0	
Klondyke	300	25,000	3,000	5,000	20.0	54.7	49.7	83.3	
Missionary	2	250	4,500	50	1.2	--.1	1.6	125.0	
McMinn	321	10,532	1,181	4/	--			32.8	75% by truck
Aroma	125	4,000	1,150	4/	--	38.9	37.9	31.9	
Blakemore	8	304	1,370	4/	--	2.4	2.8	38.0	
Klondyke	184	6,096	1,190	4/	--	57.3	57.8	33.0	
Missionary	4	132	1,190	4/	--	1.2	1.2	33.0	
Monroe	38	3,100	2,936	4/	--			81.5	100% by truck
Aroma	35	2,800	2,680	4/	--	92.1	90.3	80.0	
Blakemore	3	300	3,600	4/	--	7.9	9.6	100.0	
Meigs	660	66,600	3,632	15,600	23.4			100.9	45% by truck
Aroma	200	19,600	3,530	5,600	28.5	30.3	29.4	98.0	
Blakemore	190	21,000	3,970	2,000	9.5	28.7	31.5	110.2	
Klondyke	250	24,000	3,460	7,000	29.1	37.8	36.0	96.1	
Missionary	20	2,000	3,600	1,000	50.0	3.0	3.0	100.0	
Rhea	1,960	121,900	2,238	5,900	4.84			62.1	60% by truck
Aroma	500	24,600	1,770	1,600	6.5	25.5	20.18	49.1	
Blakemore	1,000	72,000	2,628	3,000	4.1	50.0	59.8	73.0	
Klondyke	340	18,000	1,900	1,000	5.5	17.3	14.7	52.7	
Missionary	80	4,200	1,890	200	4.7	4.08	3.4	52.5	
Premier	40	2,100	1,890	100	4.7	2.04	1.7	52.5	

TABLE XI (Con't.)

STRAWBERRY PRODUCTION IN 16 LEADING TENNESSEE COUNTIES - 1935 1/

County & Variety	Acres	Crates Produced	Yield Per Acre (Lbs.) 2/	Crates Not Harvested (Number)	Per Cent of Production Not Harvested	Per Cent Of Acreage This Variety	Per Cent Production This Variety	Index of Yield Per Acre 3/	Method of Shipments
Roane	103	7,910	2,754	4/	---	63.1	63.2	76.5	80% by truck
Aroma	65	5,000	2,770	4/	---	9.7	10.2	76.9	
Blakemore	10	800	2,880	4/	---	19.4	18.9	80.0	
Klondyke	20	1,500	2,700	4/	---	4.8	4.6	75.0	
Missionary	5	370	2,460	4/	---	2.9	3.06	68.3	
Premier	3	240	2,880	4/	---			80.0	
Sumner	1,250	99,990	2,879	990	9.9			79.9	33 1/2% by truck
Aroma	200	16,160	2,908	160	9.9	16.0	16.16	80.0	
Blakemore	600	50,500	3,030	500	9.9	48.0	50.05	84.1	
Belmont Fairfax	100	8,080	2,909	80	9.9	8.0	8.08	80.8	
Dorset	350	25,250	2,600	250	9.9	28.0	25.25	72.2	
Weakley	660	66,000	3,600	4/	---			100.00	50% by truck
Blakemore	160	22,000	4,950	4/	---	24.2	33.3	137.5	
Klondyke	500	44,000	3,170	4/	---	75.8	66.6	88.5	
Total all 16 counties									
Aroma	11,599	754,927	2,349	55,945	7.41			61.8	
Blakemore	1,336	82,553	2,225	8,375	10.14	11.70	11.09	88.8	
Klondyke	3,030	266,564	3,200	15,690	5.88	26.58	36.20	54.3	
Missionary	6,424	349,263	1,957	29,525	8.45	56.35	46.94	62.0	
Premier	116	7,227	2,235	1,275	17.64	1.01	.96	54.1	
Belmont & Fairfax	43	2,340	1,950	100	4.27	.37	.34	80.8	
Dorset	100	8,080	2,910	80	9.90	.87	1.07	72.2	
Others	350	25,250	2,600	250	9.90	3.07	3.30		
	200	13,650	2,450	650	4.76				

Source: Figures supplied by county agents
 2/ Includes estimated quantities not harvested
 3/ 3600 lbs. (100-36 lb. crates) = 100
 4/ Not reported

These data may not be very accurate but shows relative comparisons

were available. In 1929 refrigerated space in the United States had increased to about 728,594,833 cubic feet.

Early storage space was nearly all held at 32° F. or above. By 1922 about one-fourth of the total space was held at temperatures of 10° F. and below.

Refrigerated cars were introduced commercially about 1868. These early cars were cooled by the use of ice and salt. Now, ice and salt, dry ice, silica gel, frozen brine, and mechanical refrigeration are all used in transporting perishable foods.

Mr. H. A. Baker, Sr. is credited with having put up the first frozen-pack fruits in the United States. His first commercial operations consisted of following the harvesting season of berries from the south northward to Michigan.

The most common methods of quick freezing fruits, vegetables, or meats are: the Birdseye Method, the Cooke Method, the Kolbe System, and the Paterson System. All of these methods employ temperatures of minus 40° F. or below.

The commercial production of frozen fruit has grown from 1,200,000 pounds in 1918 to 68,040,000 pounds in 1934. The largest pack on record was recorded in 1930 with 81,897,514 pounds being frozen. In 1932 and 1933 the Pacific Northwest packed about 82 per cent of the total amount of fruit frozen in the United States.

The amount of fruit frozen is usually related to the amount of fresh fruit produced. About 58 per cent of all the fruit frozen is strawberries. Red raspberries come second with about 24 per cent. These are followed by blackberries, loganberries, cherries, black raspberries, and blueberries. The total value of fruits frozen in the Pacific Northwest

in 1934 was about \$3,555,635.

More counties east of the Mississippi River reported freezing operations in 1934 and 1935 than counties west of the Mississippi. However, most of the fruit is frozen west of the Mississippi River.

Usually the fruits produced in relatively large quantities in the various counties are those being frozen.

At least 45 towns practice the freezing of perishable products at the present time. 32 towns have reported quick freezing operations.

In Tennessee, freezing is done in strawberry producing areas (counties) that are close to Chattanooga, Nashville, Memphis, and Knoxville. Cold storage facilities are available in these cities.

CHAPTER II

NEED FOR, ADVANTAGES, AND PROBLEMS OF
THE FROZEN FRUIT INDUSTRYIntroduction

There is a great need for an additional outlet for fruits, especially the more perishable fruits. This need is especially indicated by the physical losses of fruit that occur during the marketing process, and by the relatively low financial returns to the producer during seasons of heavy production or during periods of depression.

This chapter brings out the more important advantages and disadvantages of the freezing industry to certain groups, and presents some of the problems involved in this type of marketing.

The Need for Additional Outlets for Fruits

In answering the question, why freeze fruits, it is easy to show that fruits have not formerly been used to the most economic advantage, and that great losses occur annually. During the past few years growers, generally, have experienced low returns which have frequently been below the cost of production. These low returns have been due to several factors, of which the low buying power of the consumer was probably most important. Demand for fruit has often been so low that growers have left large quantities of fruit unharvested. Exceptionally large quantities of strawberries and peaches were unharvested in 1933 and 1934.

Losses Due to Imperfect and Decayed Fruit. - Enormous losses occur annually to both producers and consumers of perishable products. These losses are due to decayed, small, and otherwise defective

fruit. It has been estimated that 10 to 30 per cent of the strawberry crop is lost annually due to these causes. A survey to determine consumer losses in purchasing fresh fruit and vegetables in an eastern city showed a loss of about 15 per cent in the case of strawberries (table XII). If this should be representative of consumer losses in the United States, their loss was approximately \$4,162,000 on strawberries in 1933.

If fruit is frozen losses to the consumer from decay and the like would be cut to almost nothing, and fruit might cost less per pound consumed than when it is purchased fresh.

A freezing demonstration conducted by the Tennessee Valley Authority revealed great losses in the production and marketing of strawberries. In this demonstration 329 crates of strawberries were purchased. If these crates of fruit were an average of that produced and sold on the fresh fruit market, there is approximately 30 per cent of the entire crop lost every year. The berries used in this demonstration were grown by farmers of East Tennessee and were given ordinary care and cultivation. The fruit consisted of a number of varieties and grades, most of it being field run berries.

It was found that about 17.2 per cent of this fruit was unfit for freezing, as much of it was immature. The immature fruit, however, could have been resold on the fresh fruit market. On the basis of the data worked out by the TVA, approximately 11.8 per cent of the 329 crates of fruit were unfit for any use other than juice or similar products. If the fruit had been marketed fresh after grading, the growers would have lost approximately 30 per cent of his crop due to small size of fruit, softness, caps, debris, etc. By freezing part of the crop, the loss was reduced in this experiment approximately two-thirds and resulted in a

TABLE XII

EXTENT AND CAUSES OF LOSSES TO CONSUMERS OF SPECIFIED FRUITS
AND VEGETABLES IN AN EASTERN CITY, 1935

<u>Product</u>	<u>Amount Bought</u>	<u>Per Cent Lost</u>	<u>Cause of Loss</u>
Apples, bushels	80	4	Scald and internal breakdown, blue mold, scab, scaly blotch
Beans, hampers	23	3	Soil rot, anthracnose, blight
Peas, bushels	6	1	Freezing injury, soft rot, pod spot
Potatoes, bushels	175	8	Black heart, hollow heart, freezing injury, tuber rot, scab
Sweet Potatoes, "	25	12	Rhizopus rot, stem rot, black rot
Strawberries, crates	20	15	Leak, gray mold
Raspberries, gallons	15	8	Gray mold, rhizopus rot
Carrots, crates	7	.02	Undetermined
Lettuce, crates	25	10	Tip burn, loss of moisture
Onions, bushels	75	10	Soft rot, black mold, smut, stain, freezing
Peppers, hampers	3	7	Rhizopus rot, bacterial spot, scab
Tomatoes, lugs	25	7	Phoma rot

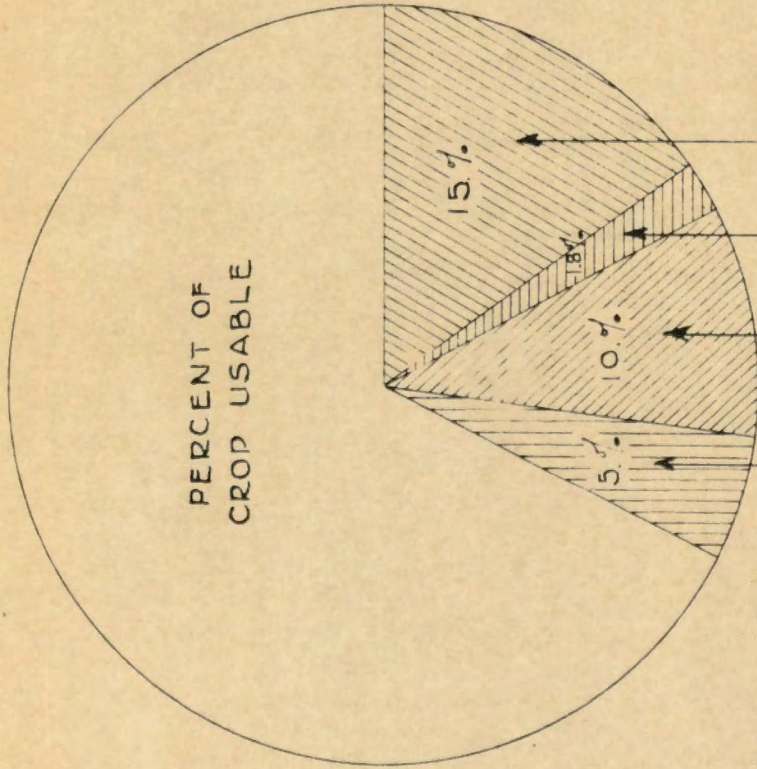
Source: Consumers Guide, p. 7. December, 1935 (Results of only one survey)

saving of 20 per cent of the entire crop. This reduction in loss was effected by reducing the loss due to soft and small berries (figure 13).

Losses from other causes remained unchanged.

Losses Due to Unharvested Fruit. - Another need for additional outlets for fruits is seen in the quantities of fruit left unharvested because of the lack of market demand during the harvest season. Even in years of relatively low production strawberries have been left unharvested. Louisiana producers left unharvested approximately 70,000 crates of strawberries in 1928; 168,000 crates in 1929; 412,000 crates in 1932; 208,000 crates in 1933; and 135,000 crates in 1934. It was also estimated that Tennessee

PERCENT OF CROP LOST
IF ALL IS MARKETED FRESH

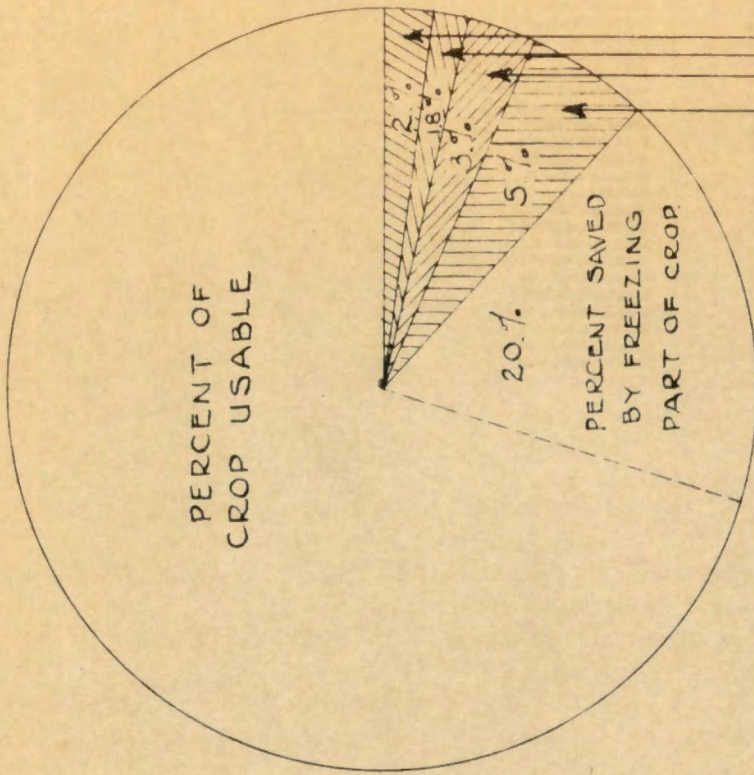


SOURCE: TVA Freezing Demonstration, 1935

- 5% LOSS DUE TO DEFECTIVE FRUIT (MASHED, MOLDED, INSECT INJURY, ETC.)
- 10% LOSS DUE TO SOFTNESS OF BERRIES (CANNOT SHIP SOFT FRUIT)
- 18% LOSS DUE TO CAPS AND STEMS WHICH ARE UNUSABLE
- 15% LOSS DUE TO SMALL SIZE OF BERRIES

TOTAL LOSS 38%

PERCENT LOST BY
FREEZING PART OF CROP



- 5% LOSS DUE TO DEFECTS (MASHED, MOLDED, INSECT INJURY, ETC.)
- 3% LOSS DUE TO SOFTNESS
- 18% LOSS IN WT. DUE TO REMOVAL OF CAPS AND STEMS WHICH ARE UNUSABLE
- 2% LOSS DUE TO SMALL BERRIES

TOTAL LOSS 11.8%

FIG. 13

POSSIBLE SAVING TO FARMER IF PART OF STRAWBERRY CROP IS FROZEN

failed to harvest 200,000 crates in 1933, and 135,000 crates in 1934. A total of about 1,129,000 crates of strawberries in 1933 and 954,000 crates in 1934 were not harvested in the United States on account of market conditions (figure 14 and table XIII). If these berries could have been sold at the average price received for strawberries, growers would have increased their total income approximately \$1,908,010 in 1933 and \$1,850,760 in 1934.

Louisiana, Tennessee, Maryland, and Delaware left more strawberries unharvested, in proportion to their area, than other states in 1934. (figure 14). It is reasonable to believe that farmers would not leave this fruit unharvested if a market could be found.

According to reports from county agents of 16 leading strawberry counties of Tennessee, approximately 7.4 per cent of the strawberry crop was left unharvested in 1935. This amounted to about 55,945 crates of fruit. If these berries had been sold at the average Tennessee price in 1935, growers would have increased their income by \$92,309. In some counties strawberries unharvested ran above 20 per cent of the crop. This was particularly true in Madison and Meigs counties (see table XI). The areas leaving most of the strawberries unharvested are usually the largest producing states. (Compare figures 14 and 15).

Not only such losses occur to producers of strawberries but to other fruit growers as well. Estimates show that large quantities of peaches are left unharvested almost every year. In 1930 approximately 10,639,000 bushels were left unharvested; in 1931, 8,063,000 bushels were unharvested; in 1932, 6,710,000 bushels; in 1933, 3,647,000 bushels; and in 1934, 2,208,000 bushels. These quantities, if valued at the average United States price would have amounted to something like \$9,362,320 in

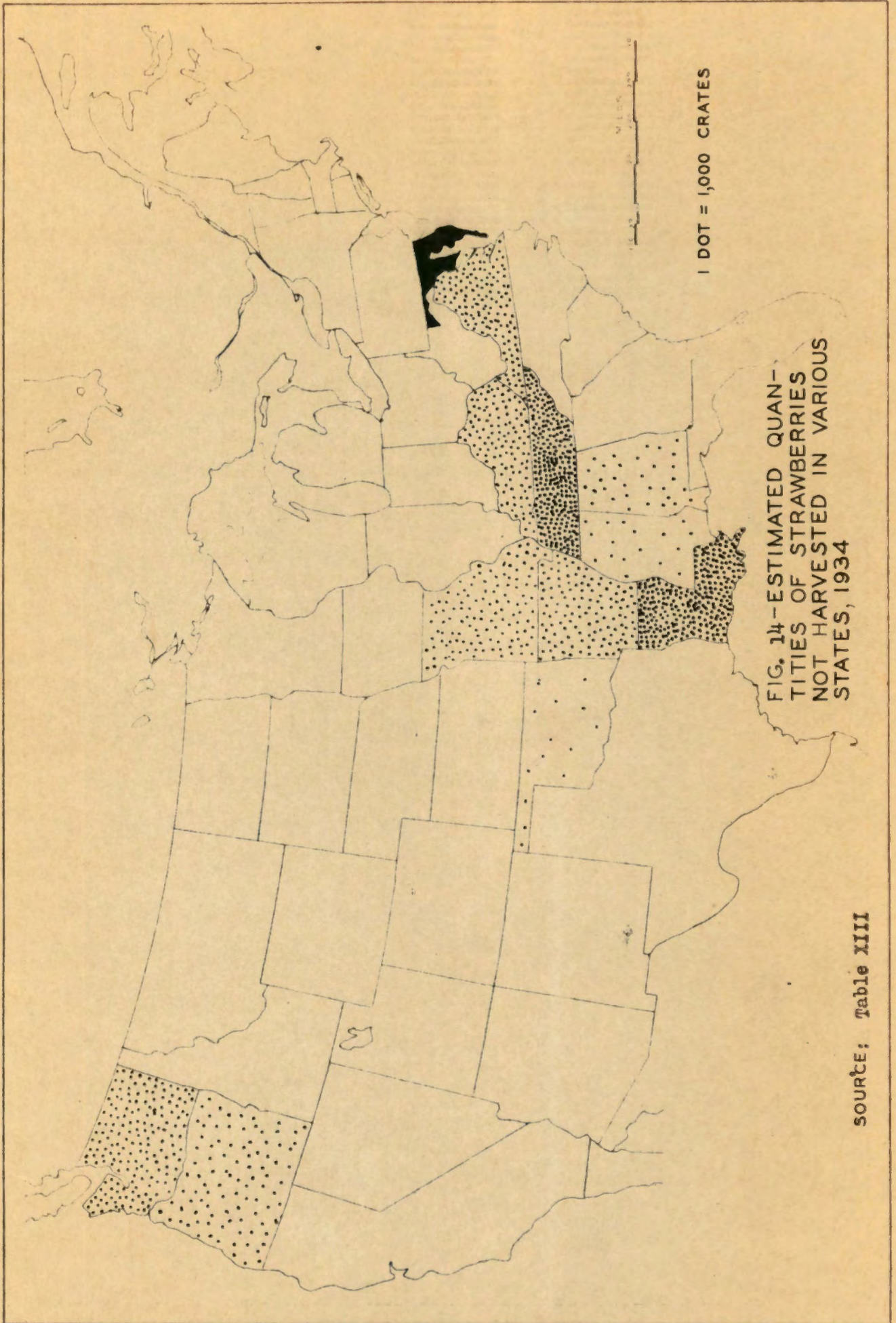


FIG. 14—ESTIMATED QUANTITIES OF STRAWBERRIES NOT HARVESTED IN VARIOUS STATES, 1934

SOURCE: Table XIII

1 DOT = 1,000 CRATES

0 50 100 150 200 MILES

TABLE XIII
 QUANTITIES OF STRAWBERRIES NOT HARVESTED

State	Crates		
	1932	1933	1934
Louisiana	412,000	208,000	135,000
Maryland		96,000	
Alabama			25,000
Mississippi			15,000
Arkansas		97,000	198,000
Tennessee		200,000	136,000
Virginia		117,000	62,000
Delaware		82,000	
Kentucky		90,000	60,000
Maryland		121,000	
Missouri	80,000	118,000	112,000
Oklahoma			13,000
Oregon			85,000
Washington			113,000
Total	492,000	1,129,000	954,000

Source: U. S. D. A. yearbook--1934 p. 545, 1935 p. 516

There was a decided decrease in the quantity of strawberries not harvested in 1934 over 1933, with the exception of Arkansas which increased about 100 per cent.

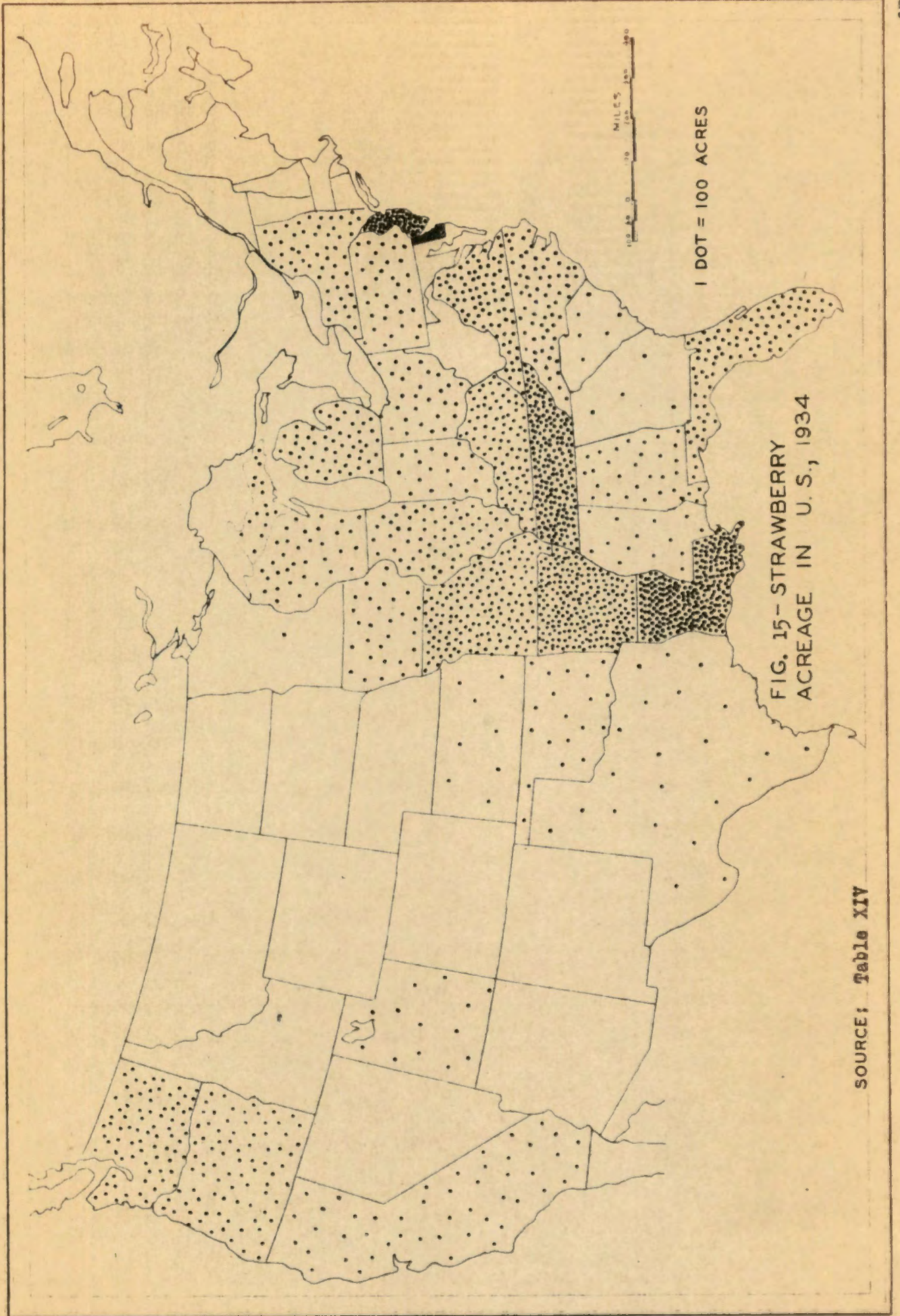


TABLE XIV

STRAWBERRIES: COMMERCIAL CROP, ACREAGE AND PRODUCTION-
1928-33 AVERAGE, ANNUAL 1933-35 1/

52

	Acreage				Production			
	1928-33 Average	1933	1934	1935 3/	1928-33 Average	1933	1934	1935 3/
Early								
Alabama	5,240	4,460	3,150	2,500	368	334	220	212
Florida	7,500	11,200	9,000	8,400	529	784	675	546
Louisiana	25,180	26,000	27,000	26,700	1,432 2/	1,248 2/	1,242 2/	801
Mississippi	1,460	3,100	1,400	600	84	124	77	36
Texas	2,090	2,000	2,160	2,300	112	80	184	69
Total	41,470	46,760	42,710		2,527 2/	2,570 2/	2,398	
Second Early								
Arkansas	16,880	19,500	22,000	7,700	819	800	1,518 2/	370
Calif.(S.Dist.)	1,580	1,600	1,150	1,100	339	352	205	230
Georgia	340	400	450	450	18	24	27	34
North Carolina	6,280	6,500	6,800	7,000	622	650	476	770
South Carolina	390	550	650	500	29	44	39	40
Tennessee	14,500	20,000	19,400	16,500	800	1,000	1,048 2/	908
Virginia	7,740	7,440	7,700	6,600	567	595	732	693
Total	47,710	55,990	58,150		3,193	3,465	4,045 2/	
Intermediate								
Calif.(Other)	2,360	3,010	3,280	3,260	450	572	784	512
Delaware	3,900	3,900	3,700	3,900	313	468	352	468
Illinois	4,590	6,000	6,400	5,800	352	420	320	348
Kansas	920	900	800	600	45	45	16	27
Kentucky	5,690	9,000	8,600	7,500	371	450	533	600
Maryland	8,280	8,060	7,250	6,500	555	846 2/	652	715
Missouri	18,120	14,800	16,000	6,600	795	622	720 2/	310
New Jersey	4,700	6,500	6,500	4,600	405	630	540	460
Oklahoma	1,480	1,800	1,900	800	49	50	76 2/	28
Total	50,040	53,970	54,430		3,235	4,103 2/	3,993 2/	
Late								
Indiana	1,590	2,150	2,100	2,000	117	183	74	220
Iowa	2,720	2,900	3,100	2,200	172	145	66	132
Michigan	4,980	5,550	5,700	5,500	343	361	285	440
New York	4,550	4,810	5,050	5,100	421	457	505	459
Ohio	2,640	3,840	2,700	2,800	160	250	189	238
Oregon	10,400	6,180	8,500	9,800	741	297	595 2/	588
Pennsylvania	2,940	3,100	3,250	3,200	268	239	260	320
Utah	1,430	1,500	1,420	1,000	98	93	43	45
Washington	8,230	7,200	7,500	8,500	567	360	638 2/	765
Wisconsin	2,890	3,000	3,150	3,300	193	195	173	277
Total	42,370	40,230	42,370		3,080	2,580	2,828 2/	
U. S. Total	181,590	196,950	197,660	163,510	12,035 2/	12,718	13,264 2/	11,681

1/ Agri. Year Book 1935.

2/ Includes some quantities not harvested.

3/ Preliminary estimates.

TABLE XV
PEACHES NOT HARVESTED ON ACCOUNT OF MARKET CONDITIONS
(Total United States)

Year	United States (1000 bu.)	Sold but left on trees (1000 bu.)	Clingstones (1000 bu.)
1926	1,297		
1927	2,709		
1928	3,842		
1929			
1930	10,639	6,180	10,139
1931	8,063	3,938	8,063
1932	6,710		
1933	3,647	1,480	3,647
1934	2,208		2,208

Source: U. S. Agr. Yearbook - 1935 - p. 496-7

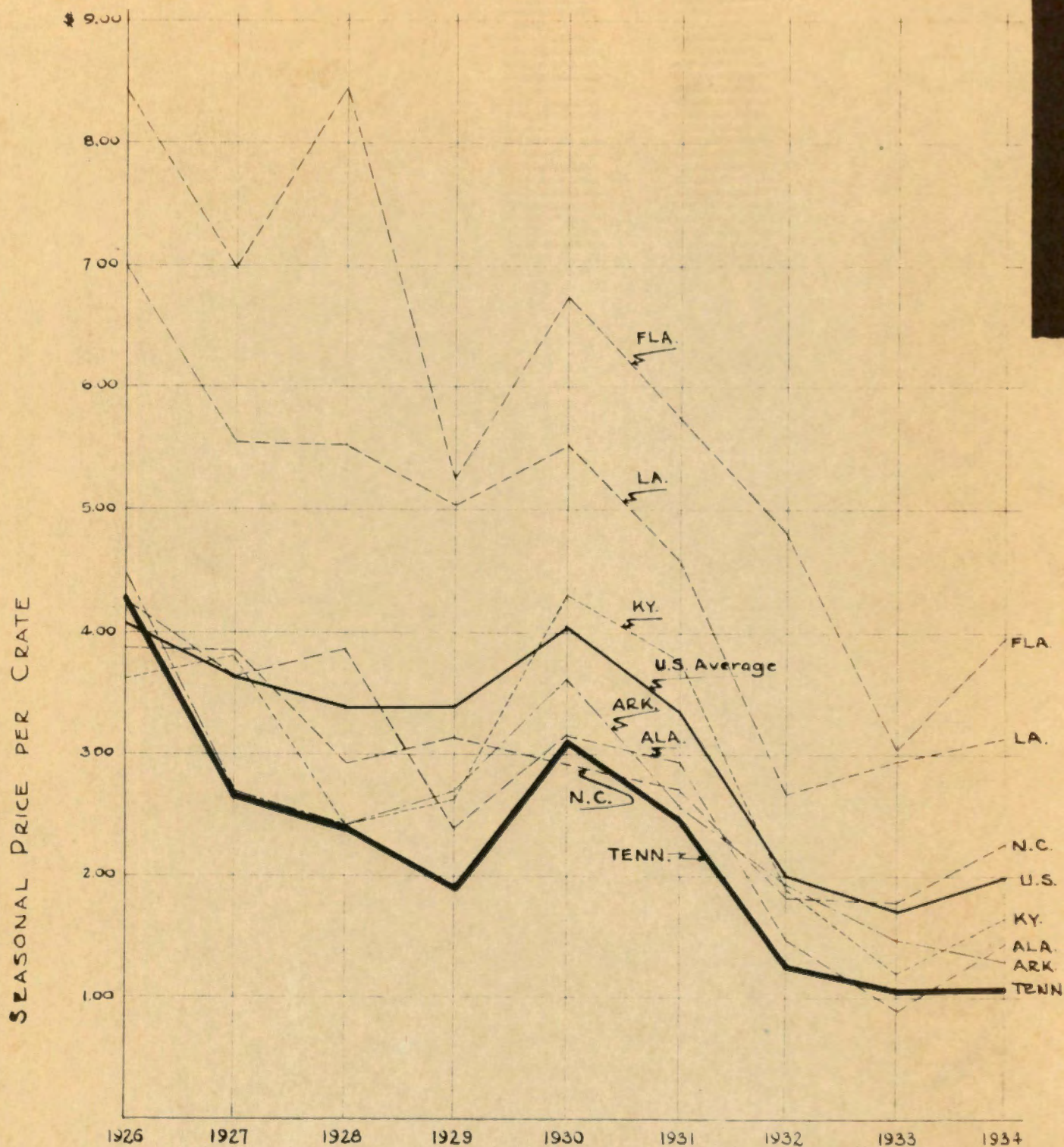
The peaches not harvested in 1934 corresponds very closely with 1927 records. The largest quantity on record as unharvested was reported in 1930 with 10,639,000 bushels. It is quite probable that the quantity of peaches produced, and possibly the quantity left unharvested is related to the age of the bearing trees. It seems evident that peach production runs in cycles of about 8 to 10 years, as the most productive life of the peach tree is at about the age of 7 to 10 years, and plantings are stimulated during years of good prices.

1930; \$4,515,280 in 1931; \$3,556,300 in 1932; \$2,771,720 in 1933; and \$1,766,400 in 1934 (see table XV).

Losses to Tennessee Strawberry Growers. - There is a need of a new outlet for Tennessee strawberries because of poor market conditions and poor quality fruit. The trend in prices received for strawberries in Tennessee has been downward since 1926, following the average trend in the United States. During 1932, 1933, and 1934 the average price received by growers in this state was below the estimated cost of production. Since 1926 Tennessee growers have received less for their fruit than growers of almost any other state. Figure 16 shows Tennessee, Arkansas, North Carolina, Alabama, and Kentucky to run fairly close together in the prices received for their strawberries, but Tennessee is consistently lower than the other states.

There are probably several reasons for the low price received for Tennessee berries. In the first place, Tennessee growers have been very careless about the grade of fruit that they sell. The writer often had the opportunity to examine the "Jumbo Pack" that is commonly sold by East Tennessee growers and found that the fruit is very irregular in size, color, and freedom from injury. Such a pack does not attract consumers, and is therefore in less demand than the better grades of fruit.

Another factor which probably tends to lower the price of fruit is the dirt and sand adhering to the surface of the berry. Growers of Tennessee do not make mulching a common practice; therefore, berries produced on plants having no mulch naturally accumulate dirt and sand during rainy seasons, which is not very noticeable on mulched berries.



SOURCE: Table XVI

FIG 16

SEASONAL PRICE OF STRAWBERRIES IN VARIOUS PRODUCING STATES

TABLE XVI

SEASONAL FARM PRICE FOR STRAWBERRIES

1926 - 1935

(Price per crate)

State	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935 1/
<u>Early</u>										
Alabama	\$4.32	\$3.60	\$5.84	\$2.40	\$3.10	\$2.90	\$1.50	\$0.95	\$1.40	\$2.10
Florida	3.40	6.96	8.40	5.28	6.70	5.75	4.80	3.00	4.20	4.30
Louisiana	6.96	5.53	5.53	5.04	5.50	4.55	2.64	2.90	3.05	3.75
Mississippi	6.47	4.80	4.32	3.36	2.65	2.75	1.87	1.05	1.60	2.40
Texas	6.96	5.28	4.80	2.88	4.30	6.25	3.85	2.85	3.35	5.70
Average	6.72	5.28	5.28	4.32	5.42	4.49	3.04	2.56	3.24	
<u>Second Early</u>										
Arkansas	4.56	2.64	2.40	2.64	3.60	2.55	1.90	1.45	1.30	1.95
Calif. (S. Dist.)	4.32	5.76	4.08	4.32	3.85	3.85	2.40	2.64	2.32	2.63
Georgia	---	3.12	2.88	2.88	2.60	2.65	1.88	1.00	1.90	3.00
N. Carolina	3.84	3.84	2.88	3.12	2.90	2.65	1.80	1.77	2.25	2.20
S. Carolina	3.84	3.60	2.88	3.36	2.90	2.65	2.06	1.72	2.00	3.00
Tennessee	4.32	2.64	2.40	1.92	3.10	2.50	1.25	1.05	1.10	1.65
Virginia	3.60	3.36	3.12	2.40	2.60	2.70	1.64	1.15	1.30	2.70
Average	4.08	3.36	2.88	2.64	3.20	2.77	1.76	1.46	1.44	
<u>Intermediate</u>										
Calif. (Other)	4.80	5.28	3.60	3.84	3.60	3.35	2.32	2.21	2.27	2.36
Delaware	3.12	2.64	1.92	2.64	2.90	2.60	1.15	0.85	1.50	2.10
Illinois	2.88	2.88	2.88	2.16	3.60	3.00	1.50	1.35	1.75	2.35
Kansas	4.08	3.60	3.36	2.40	3.60	2.40	2.20	1.75	2.00	2.50
Kentucky	3.60	3.84	2.40	2.64	4.30	3.75	1.90	1.20	1.65	2.30
Maryland	3.66	2.88	1.66	2.64	2.90	2.75	1.35	0.95	1.25	2.00
Missouri	2.88	3.60	2.64	2.64	4.55	3.00	2.00	1.60	1.75	2.75
New Jersey	3.66	2.88	2.40	2.40	3.80	2.50	1.44	1.44	1.70	2.15
Oklahoma	---	---	1.92	2.40	3.35	3.50	2.15	1.90	1.55	2.50
Average	3.66	3.36	2.40	2.64	3.69	2.99	1.72	1.39	1.73	
<u>Late Group</u>										
Average	3.84	3.60	3.60	3.84	4.03	2.69	1.56	1.67	1.86	
<u>Total U. S.</u>										
Average	4.08	3.60	3.36	3.36	4.06	3.30	1.94	1.69	1.94	2.35

Source: Agr. yearbooks - 1927-35

1/ Preliminary estimates from Bureau Agricultural Economics - Washington, D. C., Feb. 1936.

Tennessee Compared to Other States. - Surrounding states receive higher prices for strawberries than Tennessee (see figure 17). Of course, Florida, Louisiana, and Texas get their berries sold early in the season when prices are high. It must be admitted that Tennessee has plenty of competition on the fresh fruit market, as practically all of the large producing states are shipping at the same time (Table XVIII). However, states shipping at the same season usually get higher returns for their berries than Tennessee.

Some might wonder if Tennessee is a very large strawberry producing state, as states of large production would tend to produce superior fruit. Tennessee ranks high in production among the other states (see figure 18 table XVII). Since 1920 Tennessee has been one of the leading strawberry shipping states (see figure 19). According to production figures Tennessee is one of the leading producing states.

It is fairly clear that Tennessee strawberry growers receive low prices for their fruit because of poor cultural practices. Take a look at the yield per acre in the various states (see figure 20). Tennessee ranks at the bottom in yield per acre. A poor yield indicates that poor quality fruit is produced.

Just how freezing will affect these low prices and yields of Tennessee berries is not definitely known. However, it is thought that growers would be willing to take more pains to produce high quality fruit if he were assured of an outlet at a reasonable price. If high quality fruit is produced the yield per acre is almost sure to be increased. Thus freezing might be the remedy for both of these problems.

Season Price of Fresh Fruit a Factor in Determining the Time to Freeze

Fluctuation in Strawberry Prices. - First of all in determining the time

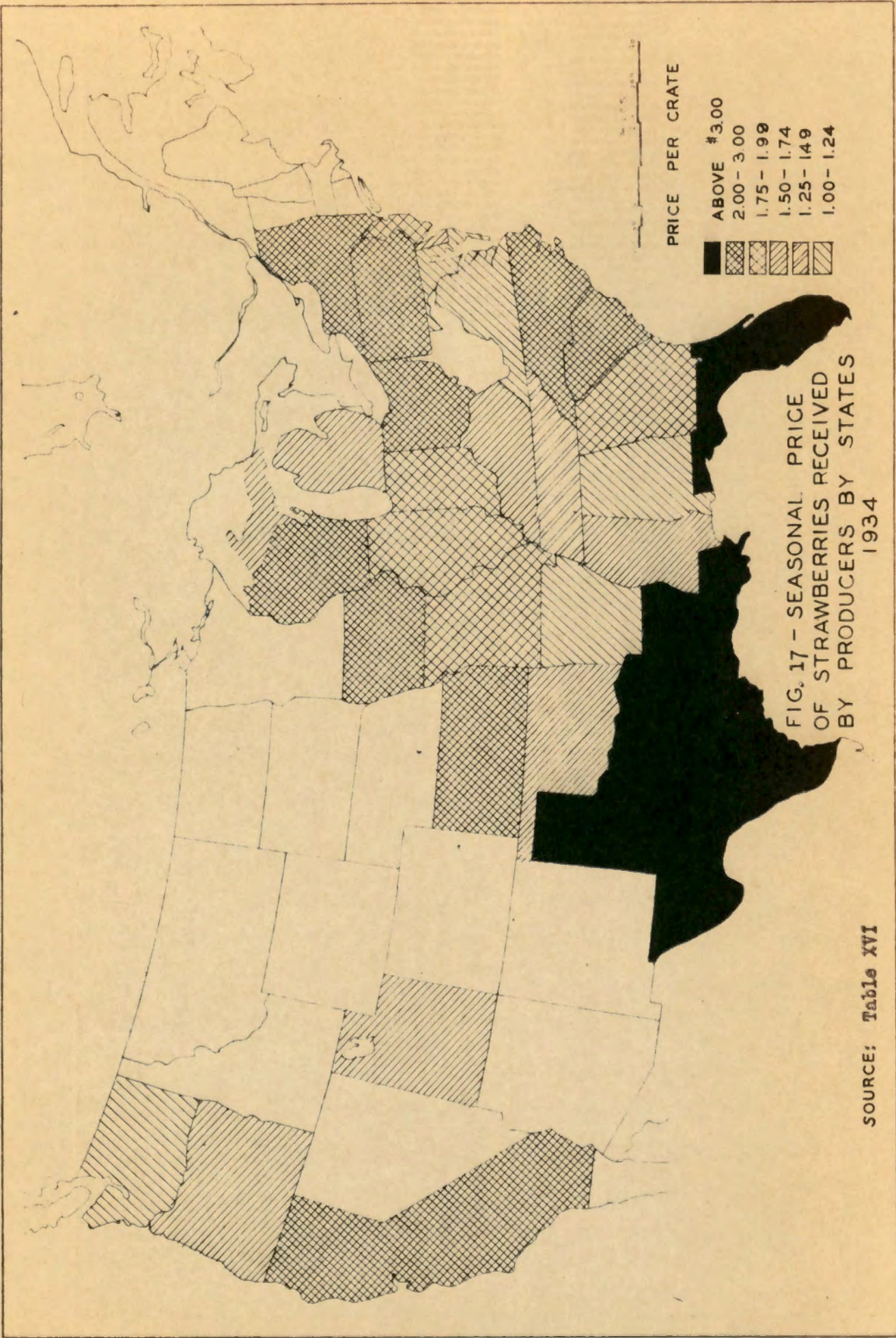


FIG. 17 - SEASONAL PRICE
OF STRAWBERRIES RECEIVED
BY PRODUCERS BY STATES
1934

SOURCE: Table XVI

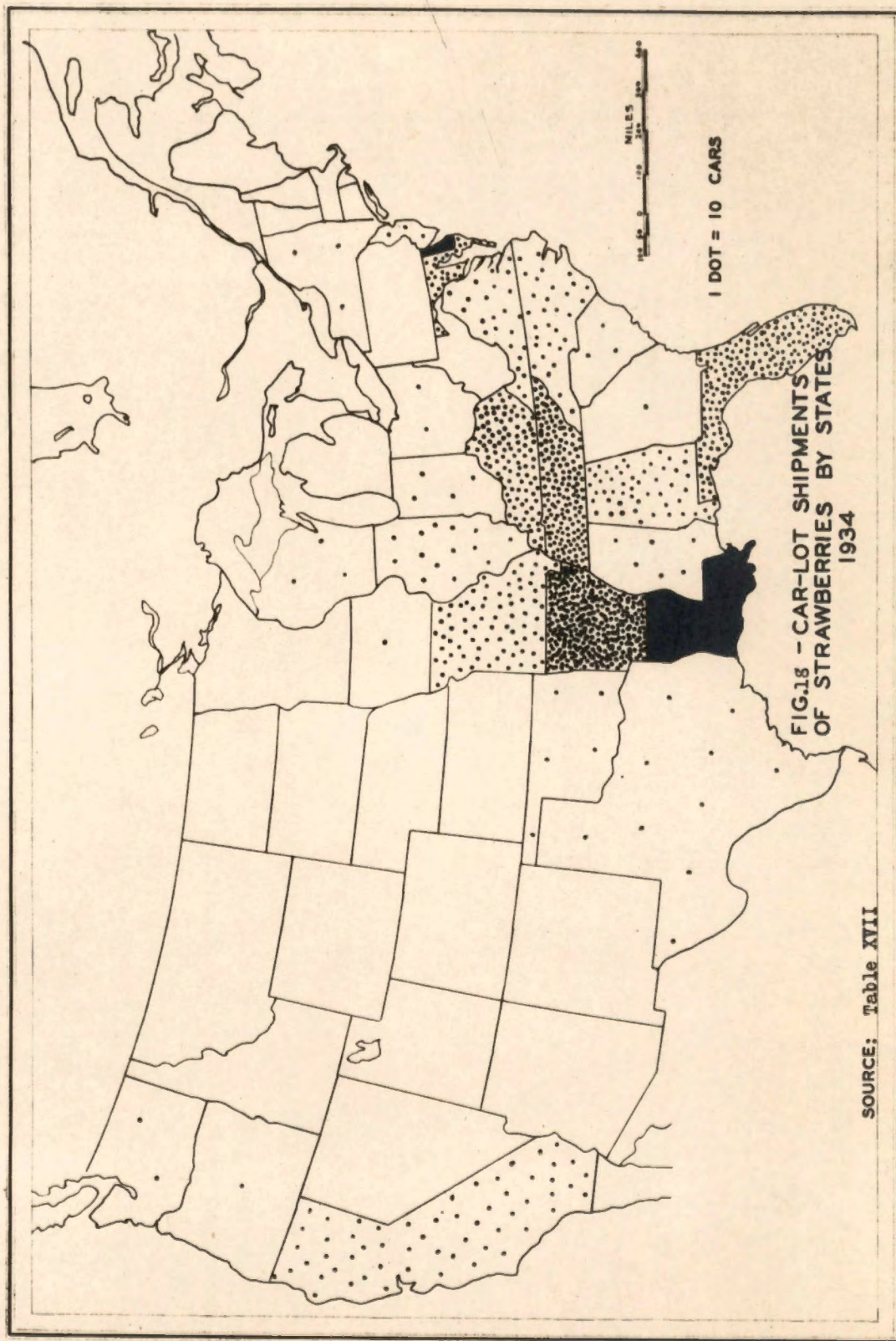
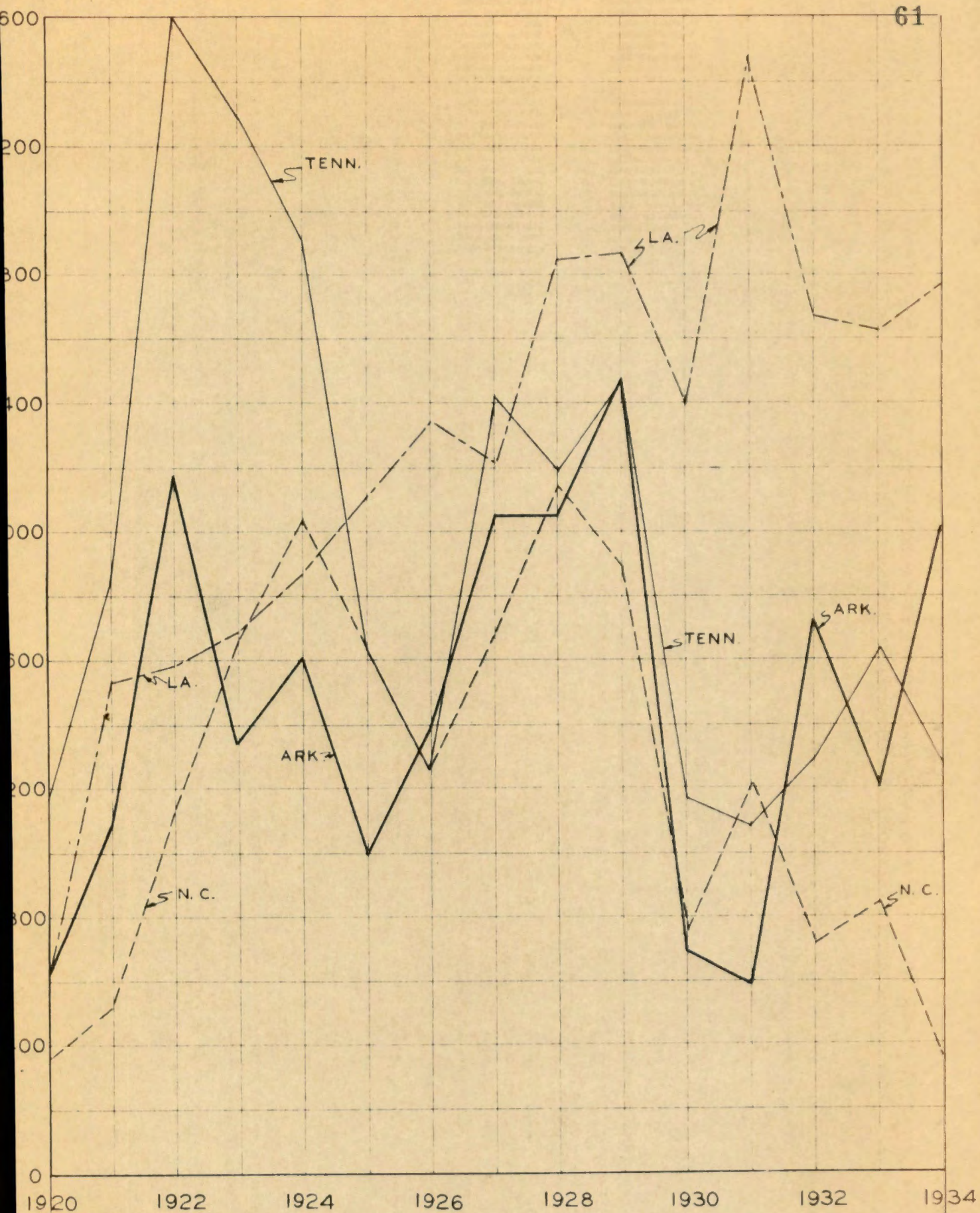


TABLE XVII

STRAWBERRY CARLOT SHIPMENTS BY STATE OF ORIGIN
(1920 - 1935 Cars)

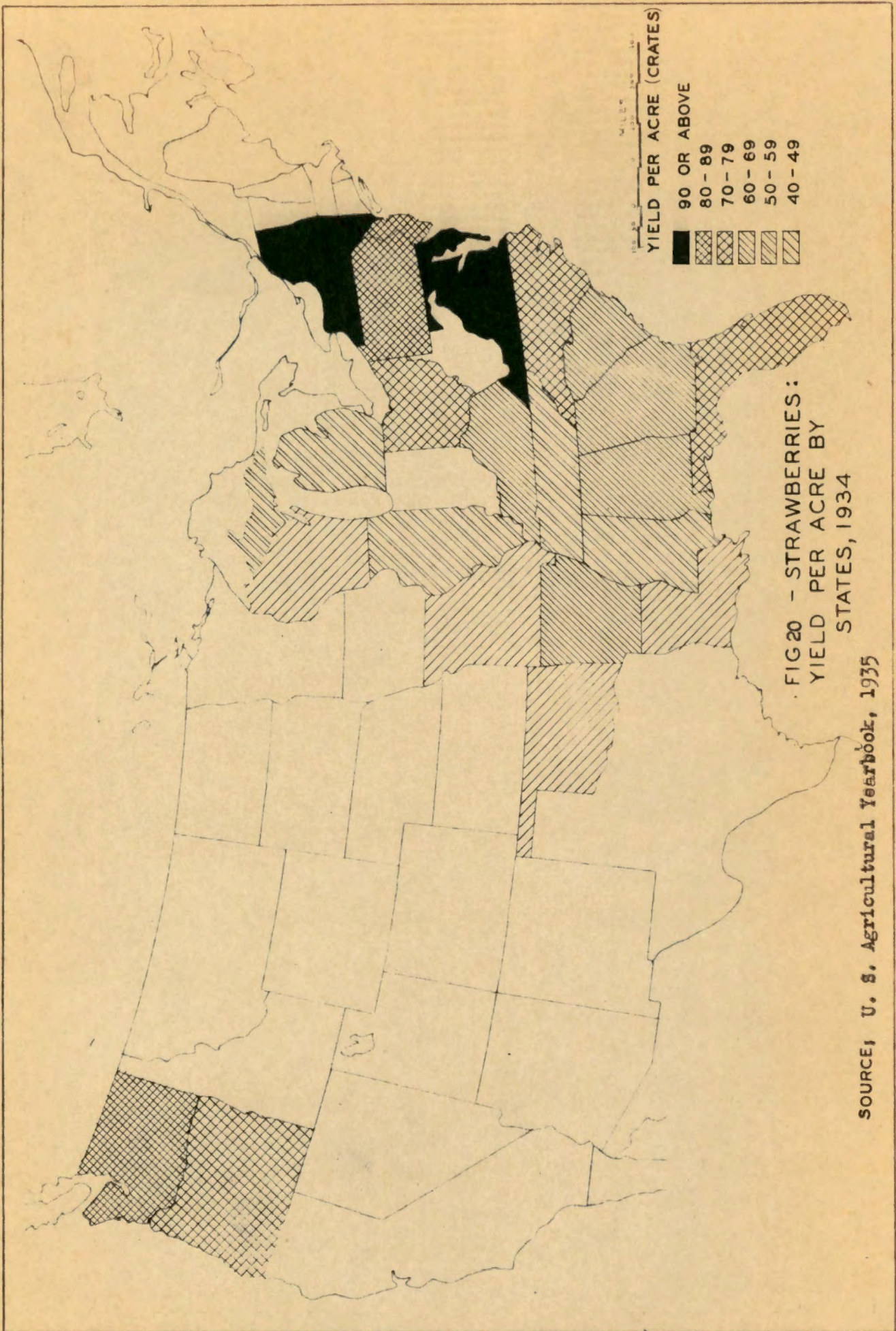
State	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
U. S. Total	7199	10865	18761	17801	18966	12256	13617	17893	18715	19378	10669	13640	13010	13252	12054	
<u>Early</u>																
Alabama	139	285	460	693	408	421	440	901	1021	1354	771	1154	755	893	450	
Florida	182	150	322	1035	580	678	341	618	545	1632	1721	1862	1760	2084	1830	
Louisiana	626	1525	1576	1678	1865	1076	2342	1659	2850	2859	2389	4720	2664	2610	2778	
Mississippi	16	38	89	141	108	54	53	65	88	113	74	127	131	114	73	
Texas	2	2	9	59	76	21	45	126	148	253	92	65	38	41	106	
Other States	---	---	---	---	---	---	---	---	---	7	6	---	---	---	3	
<u>Total</u>										6215	5053	7931	5348	5742	5240	
<u>Second Early</u>																
Arkansas	650	1087	2165	1342	1613	993	1375	2049	2046	2463	688	578	1719	1092	2144	
Calif.(S. Dist.)	---	---	20	---	7	5	---	35	18	10	16	13	75	62	18	
N. Carolina	363	503	1101	1668	2046	1634	1253	2202	2151	1870	756	1228	619	849	360	
S. Carolina	---	---	8	60	70	44	22	33	71	30	9	44	58	74	35	
Tennessee	1150	1839	3634	3279	2902	1637	1253	2425	2180	2461	1158	1066	1282	1632	1217	
Virginia	270	679	1691	1193	1919	1249	1136	1104	984	908	335	525	393	475	198	
Other States	---	---	3	27	26	20	7	20	23	18	9	17	11	13	11	
<u>Total</u>										7028	2971	3468	4159	4197	3983	
<u>Intermediate</u>																
Other States																
Calif.(Other)	---	---	14	3	---	2	---	33	46	111	39	3	12	14	---	
Delaware	258	292	181	226	184	124	104	147	141	163	203	174	362	384	405	
Illinois	652	866	940	924	1307	472	671	915	621	418	203	111	94	158	241	
Indiana	112	73	260	224	367	295	247	176	324	275	163	119	175	211	138	
Iowa	65	25	51	26	24	29	52	44	126	105	33	64	150	188	38	
Kansas	43	20	73	62	113	38	49	41	19	52	48	36	44	22	1	
Kentucky	---	---	8	19	40	20	1	57	2	63	29	23	13	15	979	
Maryland	265	395	772	827	467	312	581	976	1078	651	404	395	1087	988	241	
Missouri	793	1131	1634	1916	2155	1092	1394	1515	980	772	424	352	319	358	611	
New Jersey	245	451	1963	872	990	1497	1435	1986	2637	2076	807	692	795	765	39	
Other States	363	363	274	187	402	126	207	134	186	176	106	60	67	41	54	
<u>Total</u>										5067	2459	2029	3112	3124	2747	

Source - U. S. Agr. Year Books - 1929, 1933, 1934, 1935.



SOURCE: Table XVII

FIG. 19- CARLOT SHIPMENTS OF STRAWBERRIES (BY STATE OF ORIGIN)



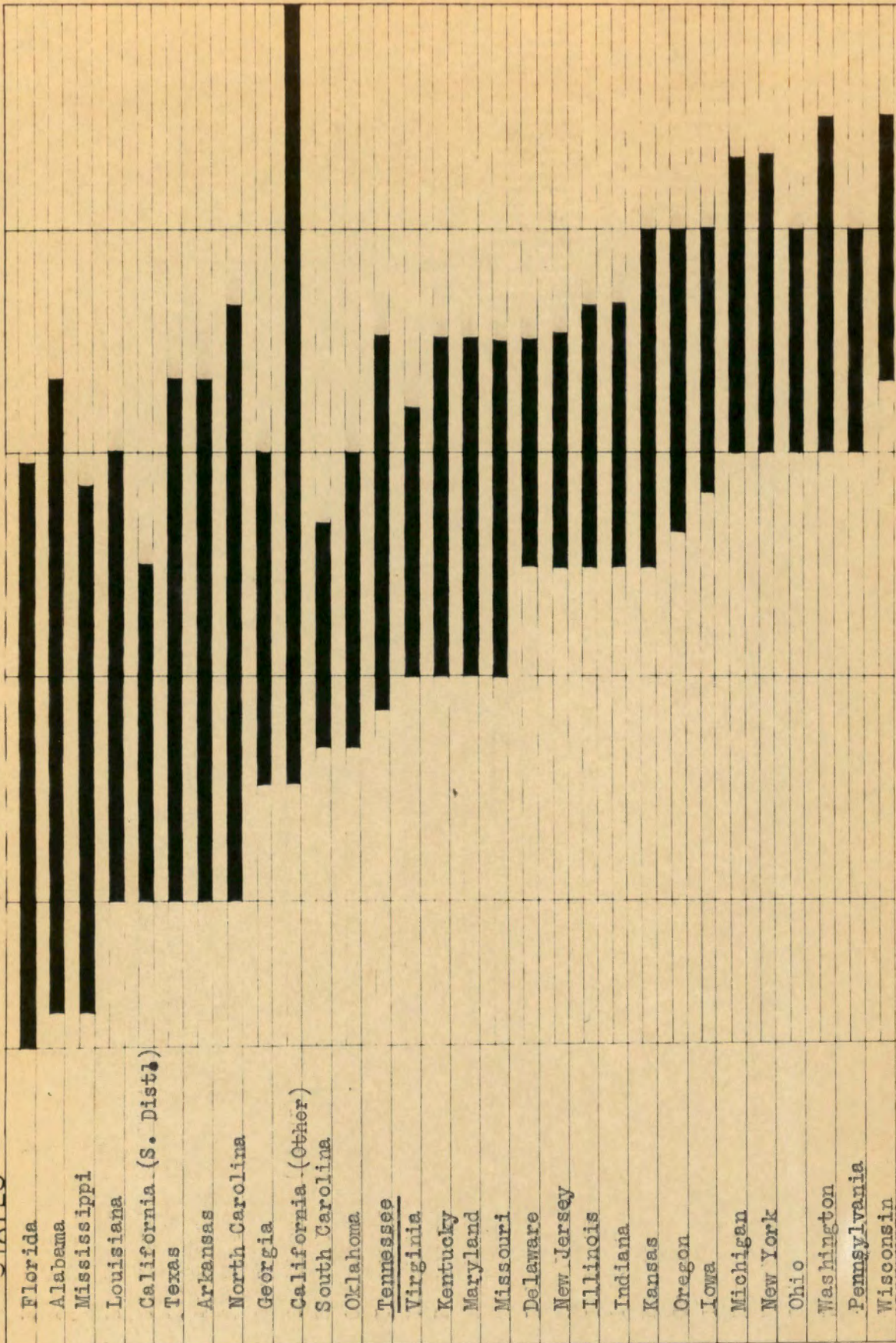
STRAWBERRY SHIPPING SEASON OF STATES

1926 TO 1930 AVERAGE ^{1/}

<u>State</u>	
<u>Early</u>	
Alabama	Mar. 15 - June 10
Florida	Dec. 15 - May 30
Louisiana	Apr. 1 - May 31
Mississippi	Mar. 15 - May 25
Texas	Apr. 1 - June 10
<u>Second Early</u>	
Arkansas	Apr. 1 - June 10
Calif. (S. Dist.)	Apr. 1 - May 15
Georgia	Apr. 15 - May 31
North Carolina	Apr. 1 - June 15
South Carolina	Apr. 20 - May 20
Tennessee	Apr. 25 - June 15
E	
W	
C	
Virginia	May 1 - June 5
<u>Intermediate</u>	
Calif. (Other)	Apr. 15 - Oct. 15
Delaware	May 15 - June 15
Illinois	May 15 - June 20
Indiana	May 15 - June 20
Iowa	May 25 - June 20
Kansas	May 15 - June 30
Kentucky	May 1 - June 15
Maryland	May 1 - June 15
Missouri	May 1 - June 15
New Jersey	May 15 - June 15
Oklahoma	Apr. 20 - May 31
<u>Late</u>	
Michigan	June 1 - July 10
New York	June 1 - July 15
Ohio	June 1 - June 30
Oregon	May 20 - June 30
Pennsylvania	June 1 - June 30
Washington	June 1 - July 15
Wisconsin	June 10 - July 15

^{1/} Source - V. H. Nicholson Marketing Eastern Shore Strawberries - Summary 1930 Season - U. S. Bureau Agr. Econ. Misc. publication - 1931.

STATES



SOURCE ; Table XVIII

MARCH APRIL MAY JUNE JULY

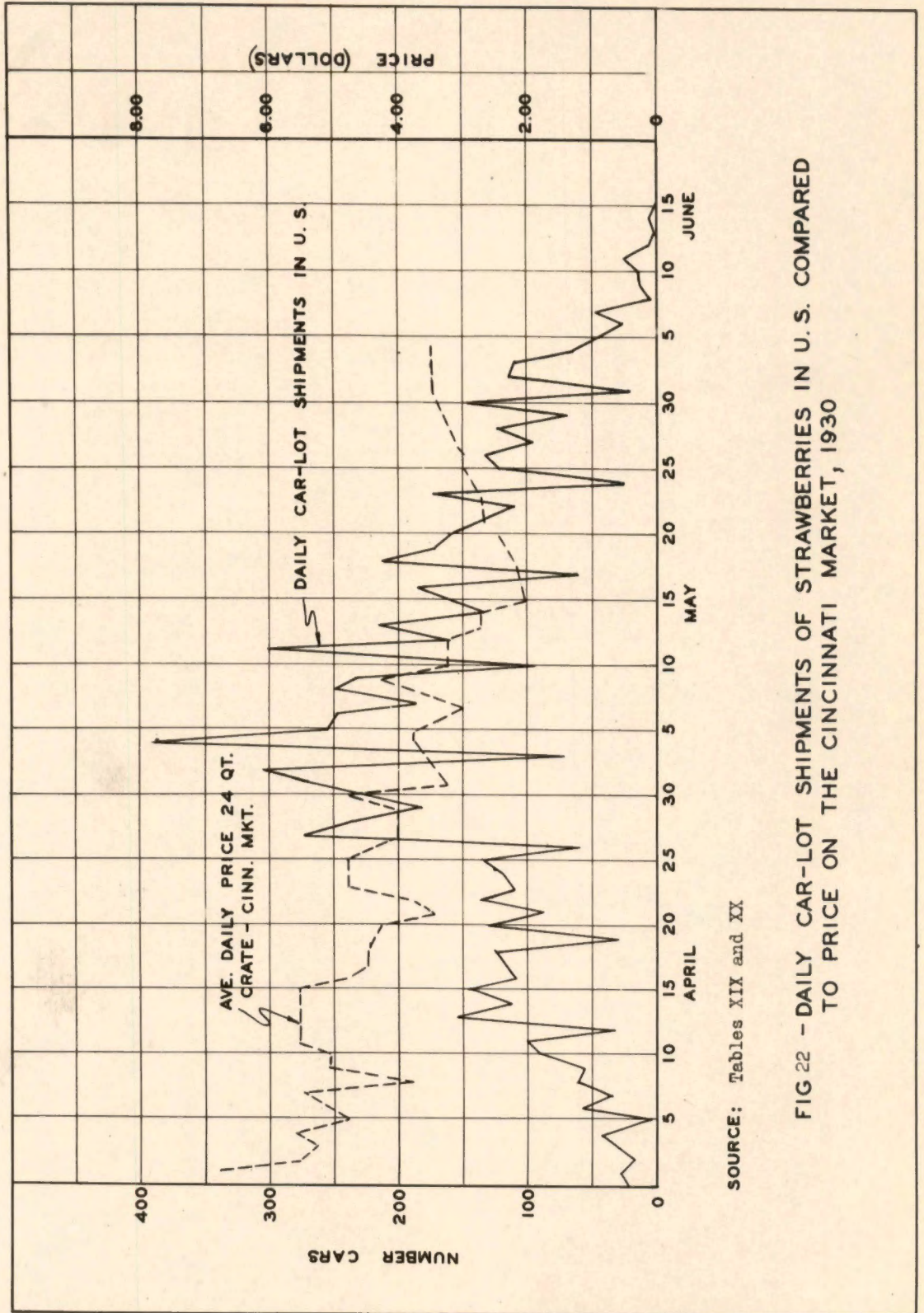
FIG. 21 - AVERAGE STRAWBERRY SHIPPING SEASON BY STATES

to freeze one should know whether or not the price of fresh fruit fluctuates, and at what time during the harvest season this fluctuation occurs. In 1930 there was a great fluctuation in price of strawberries on the Cincinnati market (figure 22). The lowest prices occurred about May 15, and continued over a period of about 10 days. Going back to 1928, we find that the prices received for strawberries by East Tennessee growers to be lowest from May 15 through the remainder of the season (figure 23). Prices on the Cincinnati and Atlanta markets in 1935 were lowest from the second week in May until the 20 of the month (tables XXIII and XXIV). In some cases they were below the cost of production. From all indications it seems that lowest prices paid for strawberries are paid from about May 10 through the remainder of the harvest season. (figure 24).

The period following May 10 then might be the best time to freeze strawberries in Tennessee, as it is the period of lowest prices for fresh fruit, due to the heavy shipments.

Fluctuation in Peach Prices. - Determining the time to freeze peaches by the price fluctuation is probably more difficult than in the case of strawberries. The reason for this uncertain price situation in the case of peaches is that there are two main harvesting seasons (periods). The first season usually begins about the 10th of July, and the second about the middle to the last of August. The price of peaches may be low at almost any time during both harvest periods. In 1935 the prices on the Atlanta and Cincinnati markets were slightly lower during June, which was the beginning of the season, than at any other time (figure 24). However, this early fruit is usually of inferior quality. During the first of July prices were often below \$1.00 per bushel on the Atlanta market.

In the case of peaches, freezing should be done during the



SOURCE: Tables XIX and XX

FIG 22 - DAILY CAR-LOT SHIPMENTS OF STRAWBERRIES IN U. S. COMPARED TO PRICE ON THE CINCINNATI MARKET, 1930

TABLE XIX
 CARLOT SHIPMENTS OF STRAWBERRIES IN
 UNITED STATES 1929-30 SEASON ^{1/}

<u>Date</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Oct.</u>
1	10	6	44	22	228	24	5		
2	4	10	5	29	272	117	2		
3	13	1	34	19	302	114	4		
4	18	16	35	29	72	66	1		
5	16	13	14	43	384	45	3		
6	--	18	18	5	256	27	0		
7	16	13	31	57	247	50	2		
8	17	11	38	36	187	7	3		
9	12	15	5	62	246	15	0		
10	10	--	23	56	233	16	2		
11	18	11	37	90	97	28	0		
12	--	13	19	102	299	8	0		
13	3	8	21	33	161	3	0		
14	27	1	31	154	214	8	1		
15	23	22	27	113	129	4	1		
16	19	5	4	146	162	8	0		
17	11	13	23	110	183	7	1		
18	18	14	35	118	63	6	0		
19	11	5	26	127	213	4	1		
20	3	13	25	28	172	3	0		
21	13	18	23	130	161	3	0		
22	9	24	27	89	126	0	1		
23	8	4	3	137	111	0	0		
24	7	42	24	111	173	2	1		
25	8	36	21	119	29	3	0		
26	7	37	11	133	122	7	1		
27	6	25	10	60	133	2	0		
28	6	32	10	270	96	5	0		
29	13		21	235	123	0			
30	9		3	180	72	6			
31	7		17		146				

^{1/} Allred, Hopkins, and Atkins - Some Economic Problems of Strawberries:
 1932, p. 187.

TABLE XX

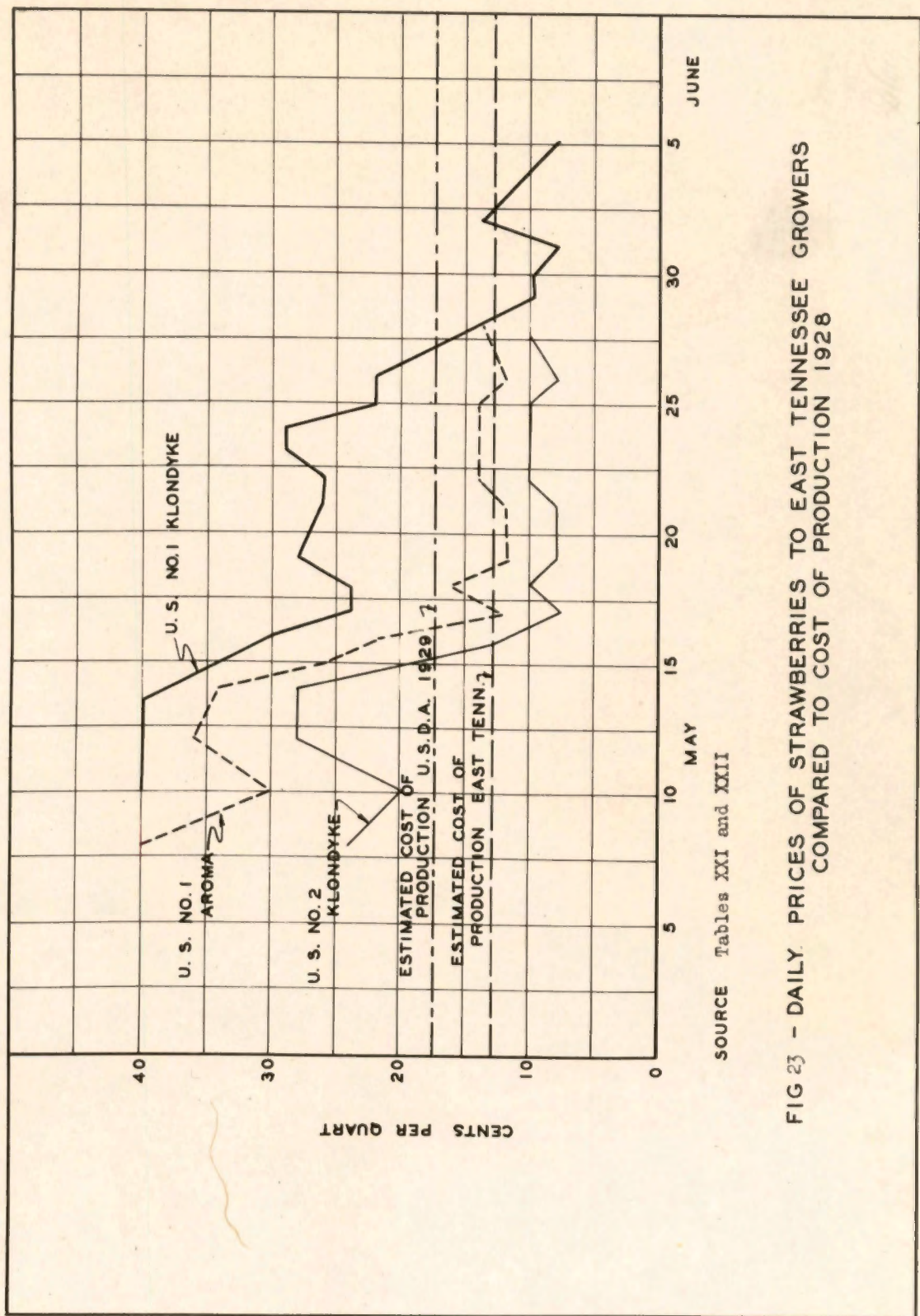
DAILY PRICE ON CINCINNATI MARKET TO JOBBERS FOR STRAWBERRIES, 1930 ^{1/}

(Price per 24 qt. crt. of Klondyke berries)

Average

Date	April	May	June
1		\$4.50--5.00	
2	\$6.50--7.00	3.00--3.50	\$3.00--4.00
3	5.00--6.00		
4	5.00--5.50		3.00--4.00
5	5.00--6.00	3.50--4.00	3.00--4.00
6		3.75--4.00	
7	4.50--5.00		
8	5.00--6.00	2.75--3.25	
9	3.50--4.00		
10	4.50--5.50	4.00--4.50	
11	4.50--5.50	3.00--3.50	
12	5.00--6.00		
13		3.00--3.50	
14	5.00--6.00	2.50--3.00	
15	5.00--6.00	2.50--3.00	
16	5.00--6.00	2.00--2.25	
17	4.50--5.25	2.00--2.25	
18	4.00--5.00		
19	4.00--5.00	2.00--2.50	
20		2.25--2.50	
21	4.00--4.50	2.50--	
22	3.00--4.00	2.25--3.00	
23	3.25--4.25	2.50--3.00	
24	4.50--5.00	2.50--	
25	4.50--5.00		
26	4.50--5.00	2.75--3.25	
27		2.75--3.25	
28	3.50--4.50	3.00--3.25	
29	3.50--4.50		
30	3.50--4.50		
31			

^{1/} Allred, Hopkins, Atkins, Some Economic Problems of Strawberries: 1932, p. 187



SOURCE Tables XXI and XXII

FIG 23 - DAILY PRICES OF STRAWBERRIES TO EAST TENNESSEE GROWERS COMPARED TO COST OF PRODUCTION 1928

PRICES PAID TO EASTERN TENNESSEE GROWERS FOR STRAWBERRIES
BY GRADE AND VARIETY ON DESIGNATED DAYS 1/
(1928)

Date	Price per qt. Klondyke		Price per qt. Arcma		Date 1928	Price to Growers 2/		
	No. 1	No. 2	No. 1	No. 2		North Carolina	Tenn. W.	E.
May 8	.20	.12			Apr. 22	.28		
10	.15	.11	.20		23	.15		
12	.18	.14			24	.09		
14	.17	.14	.20		25	.08		
15	.13	.10			26	.12		
16	.11	.06	.15	.10	27	.14		
17	.06	.04	.12	.08	28	.18		
18	.08	.05	.12		29	.08		
19	.06	.04	.14	.09	30	.17		
21	.06	.04	.13	.09	May 1	.16		
22	.07	.05	.13	.10	2	.16		
23	.07	.05	.14	.11	3	.14		
24	.07	.05	.14	.10	4	.13	.21	
25	.07	.05	.11	.06	5	.09	.18	
26	.06	.04	.11	.08	6	.08		
28	.07	.05	.08	.06	7	.08	.17	
29		.04	.05		8		.18	.19
30		.03	.05	.03	9	.08	.17	
31			.04	.02	10	.08	.16	.15
June 1			.07	.04	11	.08	.15	
2			.06	.03	12	.07	.15	.17
4			.04	.04	13	.07		
					14	.09	.15	.16
					15	.07	.16	.11
					16	.06	.11	.11
					17	.07	.10	.06
Apr. 21	.19				18	.06	.08	.07
23	.16				19	.06	.08	.07
25	.18	.16			20			
26	.17	.16			21	.05	.07	.07
27	.19	.17			22	.05	.10	.08
28	.19	.17			23		.06	.11
29	.16	.13			24	.05	.08	.12
30	.14	.10	.16		25		.08	.08
May 1	.11	.08		.11	26		.13	.09
2	.10	.08	.12	.13	28		.06	.08
3		.09	.13	.10	29		.05	.04
4	.10	.08	.13	.08	30		.05	.05
5	.09	.07	.14	.13	31		.10	.04
6	.08	.07	.14	.11	June 1		.07	.07
7	.08	.07	.14	.11	2			.05
9	.06	.06	.15	.11	3			.04
10		.07	.15	.12	4			
11		.07	.15	.12	5		.08	
12		.07			6		.05	
13	.07	.07			7		.09	

1/ Allred, Hopkins, Op. Cit--1932-- pp. 20--23, Appendix
2/ Ibid - p. 197

TABLE XXII

COST OF PRODUCING STRAWBERRIES

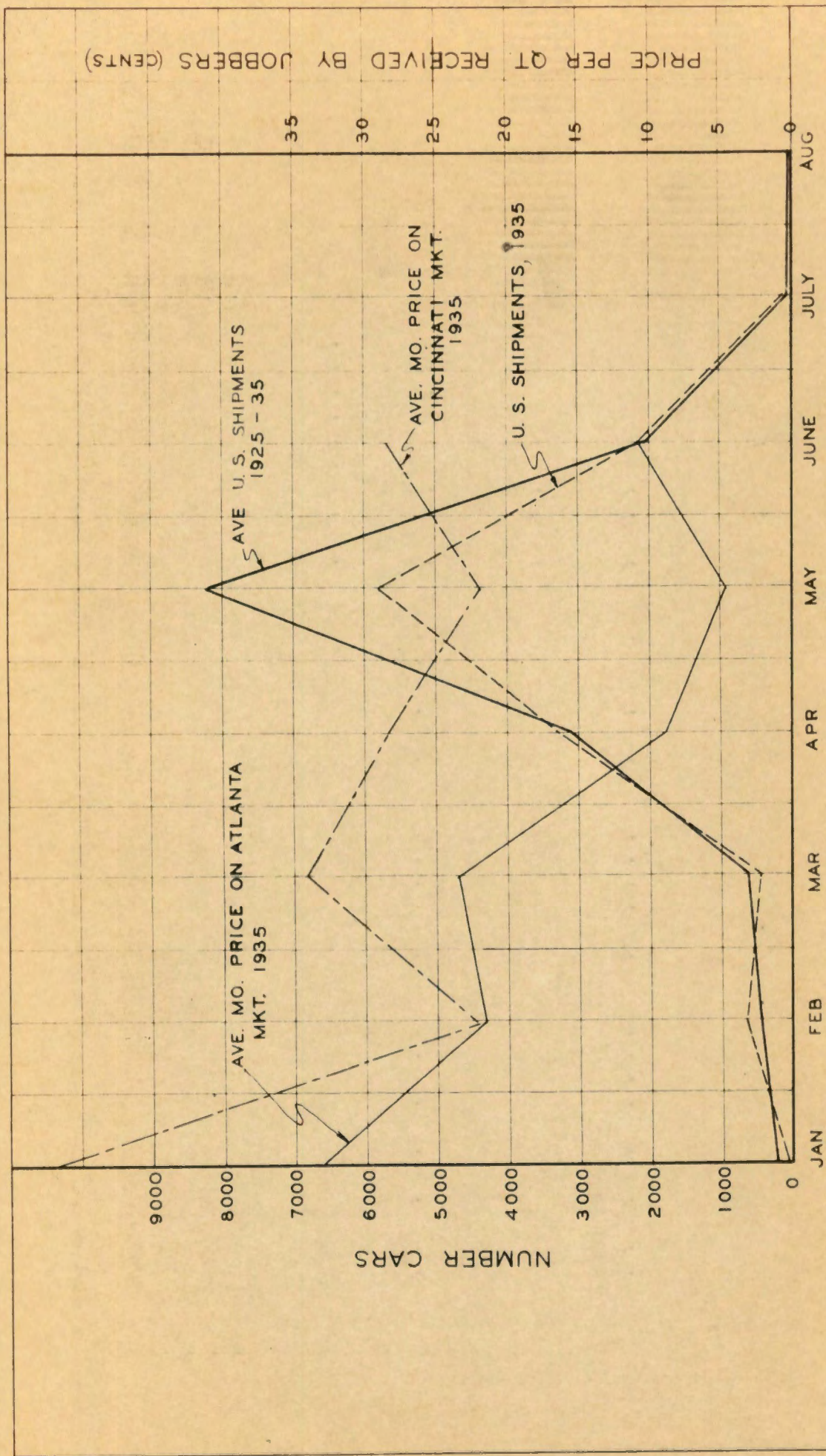
Operations	U.S.D.A. Estimates 1929 ⁽¹⁾				Tennessee Estimates ⁽²⁾		
	1st Year Labor		2nd Year Labor		1st Year Labor		Actual Cost
	Man Hours	Horse Hours	Man Hours	Horse Hours	Man Hours	Horse Hours	1st Year
Plow	5.9	11.8					
Harrow	2.5	5.0			21.8	30.0	
Prepare beds	5.1	5.9					
Plant	40.0	---			25.0	--	
Cultivate	20.0	20.0	15.0	17.0	108.0	25.5	
Hoe & weed	150.0	--	60.0	--			
Apply fert.	2.8	2.3	1.1	.9			
Misc.	10.0	13.0	7.5	9.8	35.2	27.5	
Total	236.3	58.0	83.6	27.7			\$28.50
Materials	Amount	Cost	Amount	Cost			
Fertilizer	240 lbs.	\$3.60	100 lbs.	\$1.50			5.77
Plants	6500	5.85					15.85
Crates	85	29.75	75	26.25			16.00
Other		2.00		2.00			
Total		\$41.20		\$29.75			\$27.62
Miscellaneous							
Machinery		2.30		1.10			8.06
Buildings		1.00		1.00			
Taxes		1.30		1.30			
Other		3.50		3.25			
Total		\$8.10		\$6.65			
Harvesting							
Picking	85 crts.	51.00	75 crts.	45.00			23.04
Packing		12.75		11.25			3.84
Hauling to car		8.50		7.50			4.80
Supervision		2.00		2.00			
Total		\$74.25		\$65.75			\$31.68
Grand Total		\$173.84*		\$125.75*			\$95.86
(without interest)							
Per Crate		2.05		1.68			1.499
Grand Total Per Crate		2.09		1.73			1.58
(including interest)							

* 1929 - Man Labor at 15¢ per hr; Horse Labor at 12.5¢ per hr.

(1) U.S.D.A. Costs of Production, Statistice of 1929

(2) Estimated on basis of labor records obtained at Tenn. Agr. Exp. Sta. 1932-34

(3) Yield 64 crates per acre, 1st year.



SOURCE; Table XXIII; Prices Taken From Monthly Issues of Crops and Markets

FIG. 24 - MONTHLY CARLOT SHIPMENTS OF STRAWBERRIES IN U. S. - AVE 1925-35

TABLE XXIII
 DAILY PRICE OF STRAWBERRIES TO JOBBERS ON CINCINNATI MARKET
 1935
 (Dollars per 24 quart crate)

Date	January	February	March	April	May	June	July	August
1				\$8.16				
2				7.68	2.50-3.50		2.25	
3				6.96				
4			7.44		2.00-2.50			
5			7.68			2.25-2.75		
6			8.16		3.00-2.65			
7			8.16					
8			8.16		2.00-2.50			
9	19.20							
10	19.20							
11						2.25-2.75		
12		5.76	7.68					
13		5.76				2.25-2.75		
14		4.80	6.72		2.00-2.75			
15		4.80	6.72					
16					1.50-1.90			
17					1.50-1.75	2.25-2.65		
18					1.50-2.75	2.00-2.50		
19			8.64	2.50-3.75				
20		6.24				2.00-2.50		
21		6.72	8.64		1.25-2.00	2.50-3.00		
22	12.00		8.64	3.00-3.90	2.00-2.50			
23				3.00-3.75	1.50-2.25			
24	8.64					2.50-3.00		
25			7.68	2.00-3.75		2.00-2.50		
26		6.72	8.16			2.00-3.00		
27			7.68			2.00-2.50		
28		6.72	7.68					
29	8.16							
30				3.50-4.25				
31	8.16							

Source: Daily reports from Cincinnati market--U. S. D. A. Market News Service - 1935.

TABLE XXIV
DAILY PRICE OF STRAWBERRIES TO JOBBERS ON ATLANTA PRODUCE MARKET
1935

Date	January	February	March	April	May	June	July	August
1			\$6.00	\$4.80	\$2.00-2.25			
2					1.90-2.00			
3				3.60	1.50-1.75	Few Sales		
4		6.00		5.60		2.00-2.25		
5		6.00				2.25		
6		6.00				3.25-3.50		
7		6.00			1.90-2.00			
8					1.25-			
9					1.40-1.60			
10					1.25-1.75			
11					1.25-1.50			
12	4.80		4.80		1.10-1.50			
13			4.20		Few Sales			
14			4.80		1.50-1.75			
15	4.80							
16					1.50-1.75			
17								
18			5.28					
19			6.00					
20		3.60		2.00-2.50				
21				2.50-2.75				
22			4.80					
23			6.00					
24				2.25-2.50				
25				2.25				
26		3.00	6.00	2.25				
27		2.40	6.00	2.00-2.25				
28		9.60						
29			6.00					
30		7.20		2.00-2.25				
31		7.20		1.50-1.90				

Source: U. S. D. A. Daily Market News Service - Atlanta Produce Market - 1935.

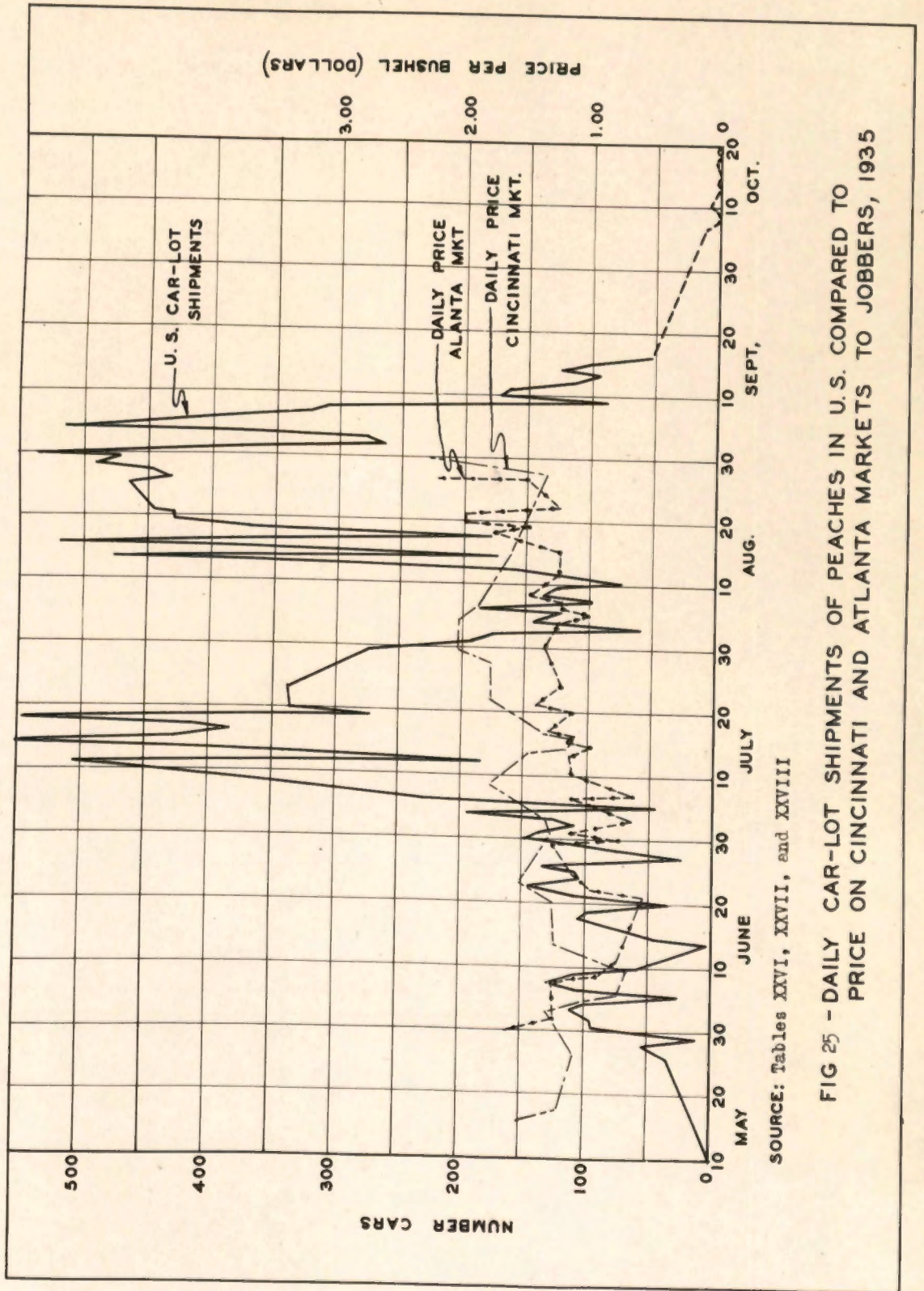
TABLE XXV

THE SEASONAL SHIPMENT OF STRAWBERRIES IN THE UNITED STATES
1925 - 1935 INCLUSIVE ^{1/}

	Jan.	Feb.	Mar.	April	May	June	July	Aug.
1925	236	250	332	3,017	7,290	1,088	32	--
1926	3	41	187	1,560	7,164	4,281	268	--
1927	21	227	956	4,524	9,679	2,328	142	7
1928	11	58	417	2,646	10,964	4,606	99	9
1929	172	675	844	5,053	10,406	1,424	51	--
1930	359	439	662	2,942	5,460	647	33	6
1931	194	442	826	3,220	6,963	1,983	29	--
1932	599	613	414	2,293	7,360	1,533	44	--
1933	511	936	663	3,379	9,729	1,212	13	--
1934	397	515	728	2,678	9,690	1,339	57	--
1935	107	686	421	3,213	5,839	2,075	131	--
Total	2,610	4,882	6,450	34,525	90,544	22,416	899	22
11 Yr. Ave.	237	443	586	3,138	8,231	2,037	81	7

^{1/} Carlot Shipment of fruits and vegetables Stat. Bul. 48 and monthly reports from Crops & Markets - 1933, 1934, 1935.

An eleven year average of monthly shipments of strawberries shows the month of May to be leading with an average of 8231 car loads. April came second with an average of 3138 cars, followed by June with 2037 cars. (See Table XXV) If an average of 8231 cars are consumed during May, what would prevent there being a market for nicely frozen strawberries during July, August, September, October, November, and December when there is practically no small fruit on the market, except canned?



SOURCE: Tables XVI, XVII, and XVIII

FIG 25 - DAILY CAR-LOT SHIPMENTS OF PEACHES IN U.S. COMPARED TO PRICE ON CINCINNATI AND ATLANTA MARKETS TO JOBBERS, 1935

TABLE XXVI

DAILY CARLOT SHIPMENT PEACHES U. S.

REPORTED BY NEWS LETTER FROM ATLANTA PRODUCE MARKET 1935

Date	May	June	July	Aug.	Sept.	Oct.
1		52	97		268	
2		12	147	191	279	
3		54	140	175	515	
4		94	110	62		15
5		95	126	146		10
6			194	123	320	5
7		112	47	194	306	7
8		99	228	100	89	13
9		34		140	172	10
10		107		130	165	6
11		130	337	78	117	4
12		115	403		95	6
13		59	506	159	125	
14			185	478	98	7
15			360	176	56	4
16	2		553	517		0
17	3	1	423	400		6
18	6	43	386	179		4
19	0		410	370		6
20	9		544	425		
21	11	106	271	430		
22		102	334	445		
23		30				
24		109				
25		134	338			2
26		143		463		
27		105		430		
28		113		446		
29		133		490		
30		30		471		
31	36		272	534		

TABLE XXVII

DAILY PRICE OF PEACHES ON CINCINNATI MARKET TO JOBBERS
1935

Date	May	June	July	August	September	October
1				\$1.50-2.50		
2			\$1.00-1.75			
3			1.00-1.50			
4		\$1.00-1.60				
5			1.10-1.50			
6		.75-1.50		1.50-2.50		
7						\$.75-1.25
8				1.50-2.25		.80-1.15
9			1.25-2.00			.75-1.25
10			1.50-1.60			
11		.50-1.00	1.50-2.00		2.00-3.15	
12						
13		.40-1.00				
14						
15						1.50-1.75
16			.90-2.00			1.50-1.65
16						1.35 (overripe)
17		.75-1.50	1.25-2.00			1.25-1.50
17			.75-1.00			
18		1.00-1.50	1.25-2.00			1.00-1.35
18			.90-1.00			
19						
20		1.25-1.90				
21	1.25-1.75	.85-1.50				
22	1.25-1.50					
23	1.00-1.40		1.50-2.00			
23			1.00-1.15			
24		.75-1.50				
25			1.50-2.00			
26		.85-2.00				
27		1.00-2.00				
28						
29				.90-1.75		
30			1.50-2.00			
31				2.00-2.50		

Source: Daily Market Reports, Cincinnati Market, 1935.

TABLE XXVIII

DAILY PRICE OF PEACHES ON ATLANTA PRODUCE MARKET TO JOBBERS
1935

Date	May	June	July	August	September
1			\$1.20-1.50	1.25-1.50	
2			.50- .75	1.00-1.25	
3			.75		
4		1.20-1.60	1.00-1.25		
5		1.25-1.50	.60- .65		
6		.50- .65			
7		1.25	.60- .70	1.50	
8		.40- .65	.35- .50	1.00-1.25	
9		1.25		1.50	
10		.50- .60		.90-1.10	
11				1.50	
12			1.00-1.25	.75-1.25	
13			.35- .50	1.00-1.25	
14			.60- .65	1.75	
15			.30- .50	.80-1.50 (1.00)	
16		1.25			
17		(.35- .65)			
18		1.00-1.25			
19		.75-1.00	1.00-1.25	1.00-1.50	
20		.60- .70	.50- .65		
21		.70- .75		1.00-1.50	
22			1.00-1.35	1.75-2.25	
23			.65- .75	1.00-1.50	
24			.75-1.25		
25			.50- .65	1.00-1.50	
26			.70- .85		
27			1.00-1.35		
28			1.00-1.25		
29		.75-1.00	.50- .85	2.25	
30			1.25-1.50	1.50-2.00	
31			.50- .85	1.75	
32			1.00	1.00-1.50	
33				2.25	
34				2.00	
35	.75-1.00		1.00-1.25	2.25	
36			.50- .85	2.00	
37			1.35-1.50	1.50-1.75	
38			.60-1.00	1.25	
39		.50- .65			
40		.90-1.00			
41		.50- .75			

TABLE XXVIII (Continued)

DAILY PRICE OF PEACHES ON ATLANTA PRODUCE MARKET TO JOBBERS
1935

Date	May	June	July	August	September
26		\$1.00 .50- .75	1.10-1.35 .90-1.00		
27		1.00-1.30 .50- .75		1.75 1.25-1.50	
28		1.00-1.25 .50- .60		2.25	
29				2.25	
30					
31					

Source: Daily Market News Service, Atlanta Produce Market 1935- U. S. D. A.

period when the seasonal supply is heaviest and when prices are relatively low. The increased demand by cold-packers should have a beneficial effect on prices of fresh peaches.

Fluctuation in Price of Raspberries, Huckleberries, Blackberries, and

Dewberries. - The price of raspberries, huckleberries, blackberries, and dewberries is usually lowest during the latter part of the season (table XXIX). In 1935 the price during the last of the season declined to about \$1.50 per crate. The shipping season of these fruits are relatively short which should tend to maintain a high price throughout the fresh fruit season.

Advantages of Freezing

Very little research has been conducted on the nutritive value of frozen foods. It has been found, however, that vitamins A, B, and D are uninjured by freezing.^{1/} However, the fate of vitamin C is more uncertain. Experiments conducted by Mack and Fellers, of Massachusetts, show that frozen Howard Supreme, and Klondyke strawberries are richly endowed with vitamin C.^{2/} However, it seems likely that some losses in vitamin C would occur, should defrosted fruits and juices stand for any considerable length of time.^{3/}

Advantages of Frozen Food to Consumers (including eating establishments).

There are many advantages in the use of frozen fruit:

- (1) Frozen food is prepared and ready for use.

1/ Fellers, Carl R., "Public Health Aspects of Frozen Foods," p. 607. Mass. Agr. Exp. Sta., Contribution No. 136, 1932.

2/ Ibid, Mack, M. J., "Vitamin C Content of Strawberries and Strawberry Ice Cream," p. 3, Contribution No. 169, 1933.

3/ Ibid, Contribution No. 136, p. 607, 1932.

TABLE XXIX
DAILY PRICES FRUITS TO JOBBERS, CINCINNATI
1935

Date	Red Raspberries		Black Raspberries		Huckleberries and Blueberries		Blackberries	
	June	July	June	July	June	July	July	July
Per crate--all crates 24 qt. unless otherwise specified. Per 16 qt. Crate. Cultivated. Wild.								
1								
2		\$4.00-4.50		\$2.25-2.50			3.00-3.50	
3		4.00-5.00		2.25-2.50			1.50-1.75	
4	2.00-2.50				2.00-2.50			
5		4.00-5.00		2.25-2.50			2.75-3.50	
6					2.00-2.50			
7								
8		3.75-4.50		1.75-2.50			3.00-3.50	
9		4.00-5.00		2.50			3.00-3.50	
10		4.00-4.25		1.75-2.50	2.00-2.50		2.25-2.50	
11								
12					2.50-2.75			
13	3.00-3.25							
14		(24 pt.)						
15		1.50-1.90		2.50-3.00			2.80-3.00	1.75-2.00
16		3.00-4.00		2.00-2.50			2.50-3.00	1.75-2.00
17		3.00-4.00		2.25-2.75	2.25-2.50		2.75-3.00	1.25-2.00
18								
19	1.75							
20					2.00-2.50			
21								
22								
23		2.50-5.00		3.00-3.35			1.00-1.25	1.50-2.00
24	2.25-2.50	(24 pt.)		1.50-2.50				
25	2.00-2.25	1.00-1.50		1.50-1.75	2.00-2.25		2.50	1.50-2.00
26	1.25-1.50			1.50-1.75	2.25-2.50			1.25-1.75
27	1.50-1.75			1.50-1.75	2.25-2.50			
28								
29								
30							2.00	1.50-2.00
31								1.25-1.75

Source: Cincinnati Produce Market Daily Reports - 1935

Aug. 1
6
8

TABLE XIX (Continued)
 DAILY PRICES FRUITS TO JOBBERS, CINCINNATI
 1955

Dewberries				
Date	June	July	August	October
1				
2		\$2.25-2.75		
3		2.00-2.50		
4				
5		1.50-2.25		
6	3.75			
7				
8				
9		1.50-2.00		
10		1.50-2.25		
11	1.50-3.00	1.75-2.25		
12				
13	2.50-3.00			
14	2.25-2.75			
15				
16				
17		1.50-2.00		
18		1.50-2.00		
19				
20				
21				
22				
23		1.25-1.75		
24				
25				
26				
27	2.75-3.00	1.50-2.00		
28				
29				
30				
31				

TABLE XXX

WEEKLY CARLOT SHIPMENTS OF BLACKBERRIES, DEWBERRIES
AND LOGANBERRIES IN THE UNITED STATES 1935

	U. S.	N. C.	Ala.	Ky.	Md. E. S.
<u>January</u>					
2-8	14	13	1		
9-15	5	5			
16-22	4			4	
23-29	0				
30-July 6	2				2
<u>July</u>					
7-13	0				
14-20	0				
21-27	7				
28-Aug. 3	12				

Source: U. S. Weekly carlot shipment reports Bur. Agr. Econ. U. S. D. A.
1935

This is all the blackberries, dewberries and loganberries reported as being shipped by rail during 1935. It is quite probable that most of these three fruits are shipped by motor truck, and are not sold on markets of any great distance from the source of production.

- (2) The housewife saves much time in preparation of the food.
- (3) The consumer has no losses due to molds, leaky berries, small size, and other defects.
- (4) Frozen fruit can be used where fresh fruit can be used.
- (5) By using frozen fruit a standard product can be purchased the year round.
- (6) A greater variety of food is available.
- (7) Vitamin content of the fruit is not injured.
- (8) It is inexpensive.
- (9) Makes possible the planning of menus in advance of the seasons.
- (10) Helps prevent price fluctuation on the market.
- (11) Makes budget planning easier.

Advantages of Freezing to the Fruit Producers. -

- (1) It offers an additional outlet for surplus fruits and vegetables.
- (2) It offers an additional outlet for fruit too small to be sold on the fresh fruit market.
- (3) It will help stabilize the price of fresh fruit by spreading consumption over a longer period.
- (4) It would help adjust agricultural production to industrial production.
- (5) Frozen food does not deteriorate greatly in storage.
- (6) Frozen food is convenient to handle and requires little space in storage.

Advantages of Frozen Food to the Ice Cream and Preserve Manufacturers, etc.

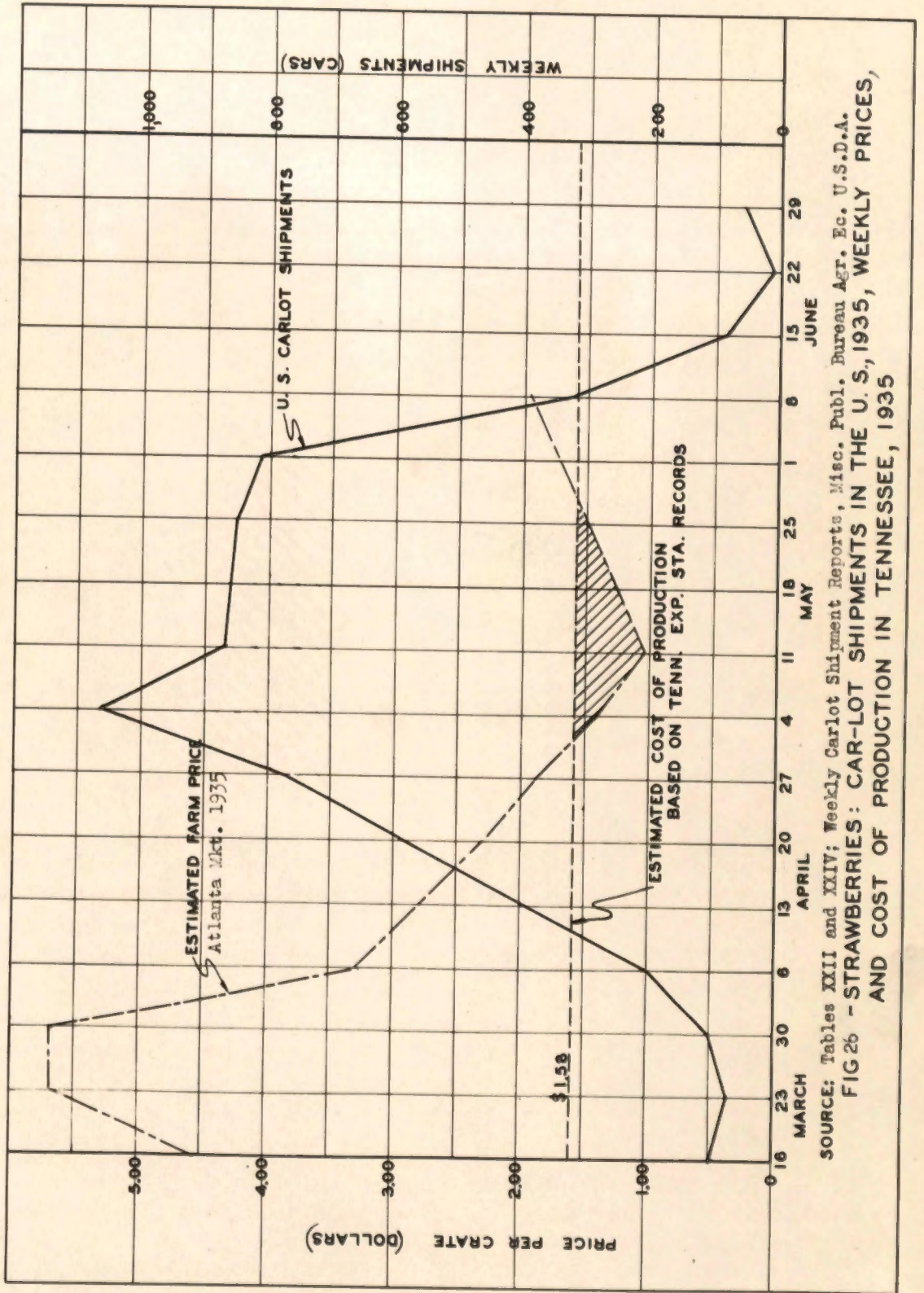
- (1) The processor has less risk in using frozen fruit because:
 - (a) He can pack according to seasonal demand for preserves, ice cream, etc. instead of making up an entire year's supply at one time, thus preventing losses from deterioration and carry over.

- (b) He is assured of getting a standard grade of fruit at anytime.
- (c) He has no losses from imperfect or decayed fruit.
- (2) The manufacturers will have less overhead costs, as the "rush season" will be eliminated thus requiring no excessive equipment, etc. as in canneries.
- (3) Transportation charges are less per pound of usable fruit than in transporting fresh fruit.
- (4) It will make possible more accurate planning of budgets.
- (5) Can make a standard quality product (same flavor) throughout the year.

The Stabilizing Effect on Price to Producers. - Since the price of fresh fruit is usually lowest at the time of the heaviest shipments, freezing might be used to minimize the price declines. While no minimum price can be guaranteed by freezing part of the crop, growers can use such a method to help stabilize the price of fresh fruit.

To illustrate the principle of this method of utilizing fruit, let us assume a situation where the total supply is greater than demand for fresh fruit prices, under such a condition will naturally drop. In fact, the supply could be so great that some of the fruit could not be sold at any price. By freezing the surplus fruit the supply of fresh fruit on the central market will be lowered, which would tend to strengthen prices.

The price of strawberries on the Atlanta market in 1935 went below the estimated cost of production (figure 26). During this period when prices were below the cost of production some of the fruit could have been frozen, lowering the supply of fresh fruit, this tending to raise the price. The increased demand by the cold-packers will not necessarily raise the price of fresh fruit above the cost of production. However, it would certainly increase the amount of fruit utilized, thus increasing the farmers' income.



SOURCE: Tables XXII and XXIV; Weekly Carlot Shipment Reports, Misc. Publ. Bureau Agr. Ec. U.S.D.A.
FIG 26 - STRAWBERRIES: CAR-LOT SHIPMENTS IN THE U. S., 1935, WEEKLY PRICES, AND COST OF PRODUCTION IN TENNESSEE, 1935

Effect of Freezing on Industrial Conditions. - Thousands of solutions have been offered to bring about an adjustment between agriculture and industry. As I see it, the ideal set-up for any community is one which offers sufficient employment, either in industry or agriculture, to provide the things necessary for a happy life. In some cases this situation can be brought about by the establishment of small industries near the source of raw materials so that people can live on small farms and at the same time work part time in the factory. The factory worker can, therefore, provide much of their food and other necessities from their small farms, having enough left from their salaries at the factory to provide a few luxuries which help to bring a much longed-for contentment.

Freezing would help very materially in bringing about an adjustment of agriculture and industry. In the first place, it would be a purely agricultural industry. It would be located close to the raw materials, and would give extra money to the people living on farms. It would help improve industrial conditions by creating a larger demand for refrigeration equipment, for building materials, for containers, and for electric power. Freezing would increase employment through an increased demand for managers and laborers in the packing plants, through the increased demand for cold storage facilities and through the distribution of the frozen product.

One wonders what will happen to those people that have depended upon jobs from the processors during "rush seasons". In the case of freezing, the packer of frozen fruit will hire the labor once hired by these processors (preservers, etc.), thus using just as much labor as was commonly used for capping, grading, and packing. Immediately one sees that more labor will be required if this system of packing is employed. Therefore, how can it be cheaper for the processor to use

frozen fruit instead of fresh fruit? An increase in employment does not necessarily mean an increase in labor cost. Steady employees usually result in producing skill and efficiency which is usually cheaper than part-time inefficient labor.

Problems Facing the Freezing Industry

Storage. - With the modern methods of refrigeration, storage of products at 0° F. and lower are quite common. Statistics for 1935 show that approximately 98,314,447 cubic feet, or about 7.24 per cent of the total refrigerated space in the United States was held at a temperature of 10° F. and below.^{4/} Storage rates at these temperatures are fairly reasonable.^{5/}

At the present time storage temperatures of 10° F. and below are as common as temperatures of 20° F. to 30° F. were ten years ago. As a result of this increase in storage at low temperatures seasonal supply of fresh fruit and vegetables is no longer a problem. Fruit and vegetables can be frozen and stored at freezing temperatures almost indefinitely.

Feasibility of Freezing. - Freezing and storage facilities must be available wherever freezing is to be done. It is not absolutely necessary that a cold storage or freezing plant be located at the point of production. However, such a location would be most advantageous. Sometimes it would be very uneconomical to construct a cold storage house for the purpose of storing only frozen fruit. It is oftentimes very practical to pack the fruit at the point of production and haul it to a nearby commercial cold storage house.^{6/} Rates for products in freezing storage are comparatively

^{4/} U.S.D.A., Statistical Bulletin 48, 1934, p. 5.

^{5/} Market Survey, Tenn. Agr. Exp. Sta., 1935 (unpublished).

^{6/} TVA Freezing Demonstration Project, 1935 (unpublished report).

reasonable being about 15 cents per hundred pounds per month, charging 20 cents extra the first month for handling and freezing.

There is the question of how much skill is required to freeze fruit successfully. In my experience, I have found that one must be able to grade and judge fruit with ease and accuracy. It takes much practice to do this job without some slip-ups. If only one poorly colored berry goes into the pack it might be so placed in a jar of preserves by some processor that it would be impossible to sell that jar of preserves. Therefore, fruit to be frozen must be very carefully graded and inspected. Another thing in freezing is the use of mature fruit. Nearly all investigators agree that fruit to be frozen should be full ripe if maximum quality is to be obtained. This means that the fruit for freezing must be riper than fruit to be shipped. To obtain this ripe fruit, growers can do one of two things: (1) they can pick the fruit as it would be done for shipping, and then grade and sort it according to maturity selling the fruit too immature for freezing on the fresh fruit market and freezing the ripe fruit; and (2) the growers can allow the fruit to stay in the field an extra twenty-four hours or so before harvesting, thereby allowing it to ripen. The determination of the proper maturity of the fruit is often a problem of growers and pickers unfamiliar with harvesting fruit at this stage of maturity. In my research work, I have found it easiest to get sorters and pickers to select full-ripe fruit by telling them to select fruit that they would prefer to eat, and fruit that is full red and reasonably soft.

In the addition of sugar or syrup, fruit is placed in the container first and the preservative added. In the case of sugar, a layer of berries and a layer of sugar is usually added until the container is full.

It is usually wise to rock the container while it is being filled to get the sugar dissolved so a coat of syrup will be formed around the fruit as soon as possible.

Competition for Frozen Fruit. - A vital question to be answered, before establishing a freezing plant, is that of competition. The consuming public can consume only so much food and to introduce a new product means that the public will have to consume less of something else if the new product is used. However, this might be explained in that the lightest shipments of fruits and vegetables usually occur during January, February, and March, and that during the summer when heaviest shipments occur much more food is consumed. Most of the fruits and vegetables produced in the United States are consumed during the summer months (table XXXI).

According to Kuznets^{7/} of New York, it seems safe to assert that only a minor part of the seasonal variation in consumption is due to the direct influence of seasonal changes in final demand. Fruits and vegetables constitute part of a well-rounded diet throughout the year. This heavier consumption in summer may be attributed largely to the scarcity during the winter months and much less to increased demand in the warm seasons. "We find, that unlike milk products, the products manufactured from fruits and vegetables account for a relatively minor fraction of the total output. Furthermore, fruits and vegetables cannot be converted at will into durable products; manufacturing utilization requires definite qualities in the raw material, qualities often incompatible with those needed for profitable sale of the final consumer."^{8/}

Some say we could can all the fruit instead of freezing it.

^{7/} Kuznets, Simon, Seasonal Variations in Industry and Trade, p. 82. The Lord Baltimore Press, Baltimore, Maryland, 1933.

^{8/} Ibid, p. 82.

TABLE XXXI

UNLOADS OF CERTAIN FRUITS AND VEGETABLES
IN 66 CITIES IN THE UNITED STATES 1/

1933

Total for 66 Cities

Commodity	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Apples	3906	3419	3876	2504	2134	1172	1207	993	2954	6269	4242	3420	33996
Cabbage	2368	2362	2607	2253	2497	1035	268	575	987	1532	1479	1712	19695
Cantaloupes	74	95	91	213	398	3483	6474	3038	2499	1084	160	32	17641
Celery	1853	1791	2167	1846	1501	827	274	244	743	1066	1499	1710	15521
Grapefruit	2427	2167	2628	2246	2251	1313	610	292	832	1576	2128	1907	20377
Grapes	328	29	73	192	147	17	276	1134	3344	10047	8934	2061	26582
Lemons	650	581	685	729	1286	2284	1596	1170	780	732	788	608	12089
Lettuce	2940	2932	2986	3242	4085	2846	3200	2785	2601	2628	2568	3088	35901
Onions	1768	1683	2239	1794	2911	2043	1610	1338	2306	2528	1575	1740	23535
Oranges	6031	6292	6804	6626	7027	6660	4157	3999	3565	4202	5645	6540	67548
Peaches	1	5	2	1	1	975	6177	4953	2036	167	--	--	14318
Pears	368	299	293	196	128	22	416	1709	2325	1598	744	242	8340
Plums	11	--	--	--	1	250	958	636	1312	396	2	--	3566
Potatoes	9252	8657	11900	11447	13015	14213	8823	7057	9634	11789	9619	8597	124003
Strawberries	426	830	571	2168	5613	947	20	2	--	--	--	8	10585
Sweetpotatoes	852	756	735	598	388	233	223	537	1226	1275	1092	1022	8937
Tangerines	894	837	496	73	--	--	--	--	--	1	386	1097	3784
Tomatoes	1239	1404	2114	2489	3350	5160	2682	495	454	1462	1541	804	23174
Watermelons	--	--	--	5	741	3899	10225	5454	1060	15	--	--	21399
Total	35588	34139	40267	38622	47474	47379	49196	36411	38558	48367	42402	34588	492991

1/ U. S. D. A. Market News Service, Bur. Agr. Econ. "Carlot Unloads of certain fruits and vegetables in 66 Cities in United States, 1933. p. 67

However, in the canning of fruits the original fresh flavor of the product is invariably altered, and a cooked taste usually attained. In freezing, the original fresh flavor is preserved almost perfectly if the fruit is packed and frozen by the proper method. In the case of some fruits canning is a poor method of preservation and not practiced very extensively. Very few strawberries are canned compared to the amount produced. Tennessee produces many more strawberries than the total quantity canned in the United States. The small quantity canned may be due to the fact that strawberries lose their natural color and flavor when canned. The canning industry has never been able to utilize all the surplus fruit, even in the case of peaches which is adapted to canning. Freezing could easily be used to supplement canning.

The freezing of fruits and vegetables would lengthen the season of usefulness of nearly all seasonal products. The supply of fruits and vegetables in the United States comes in more or less short periods during which large quantities are forced upon the consumer (see figure 13, 14, and 15). Too, during these short periods of abundant supply, producing states suffer much competition. However, in freezing the southern states have a seasonal advantage over the Pacific Northwest in that berries are available from the south one to two months earlier than from the northwest. Brokers and dealers located at the central markets say they would welcome a good grade of "frozen pack" strawberries from the south as it would be on the market so much earlier than those from the northwest.^{9/}

Distribution Problem. - The distribution of frozen food is a major problem. It is a comparatively simple matter to transport the barrels of fruit from one large city to another as refrigerated railway cars and motor trucks

^{9/} Op. cit., Market Survey, Tenn. Agr. Exp. Sta., 1935.

are equipped to handle frozen products. But if frozen fruit is to be used by individuals or by the small restaurants, hotels, clubs, etc., how is it to be handled? Some have suggested the idea of handling frozen fruit through ice cream manufacturers.^{10/} Refrigerated display counters, similar to those used in meat markets, could be used by retailers if they were equipped to maintain temperatures of around 10° to 15° F. Construction of such a counter is very difficult as it is hard to prevent the glass from becoming frosted when low temperatures are maintained within them. However, consumers do not see ice cream or fruit ices before they are purchased, which indicates that quite a bit of trade might be built up through advertising without display cabinets.

Consumers of frozen food need not worry about the fruit spoiling before it can be prepared and used. A container of frozen strawberries of only one-half pound capacity requires approximately two hours for complete thawing at 90 to 95° F. Even when it thaws it remains in good condition for 12 to 24 hours and can be used for short-cake, preserves, etc. for as long as 48 to 60 hours after defrosting. If placed in the freezing cabinet of ordinary household electric refrigerator the frozen product can be kept indefinitely. If left in the refrigerator at 40 to 45° F. the product can be kept as long as fresh fruit would ordinarily be kept. If sealed containers of fruit are purchased, a small hole should be made in the top of the container to prevent the escape of air during the thawing process. If this is not done the container may explode causing minor damages.

Maintaining Proper Conditions in the Freezing Process. - Unless freezing is done properly the process is a failure. To be successful one must, therefore, know how freezing effects fruit. Upon knowing these physical

^{10/} Berfield, B. F., "Frozen Fruit Makes Its Bow to the Consumer", Printers Ink Weekly, Reprint 2, April 4, 1929, p. 48.

and biological effects of freezing preservation one can immediately see the problems involved in maintaining favorable conditions for this process.

Relation of Bacteria to Temperature: - There are three well recognized groups of microbes, depending upon the temperature conditions under which they will thrive and grow. First, there are three cold-loving bacteria; second, the heat-loving bacteria, or those that grow best at temperatures many degrees above the internal temperatures of our bodies, or what we call blood heat (37° C); and third, the middle group which lies between both extremes and comprises by far the great majority of bacterial life and those of the greatest importance today.^{11/}

Heat is more effective than cold in bringing about destructive action on bacterial life. With the lowering of temperature there is a lowering of the rate of activity, the organisms grow and produce more slowly and the chemical activity they induce becomes less and less. Below the minimum temperature for growth they cease activity altogether. However, one must reduce the temperature quite markedly or hold it for long periods of time in order to destroy any appreciable number of the bacteria. In general, temperature below 10° C. (50° F.) inhibit bacterial growth rather effectively, while molds and yeast may not be completely restrained.^{12/}

The Physical and Biological Aspects: -

- (1) Dessication. - Regardless of the freezing temperature or the holding temperature products usually lose moisture in cold

^{11/} Prescott, Samuel C., "Bacteria as Affected by Temperature," Refrig. Eng., Feb. 1932, p. 91.

^{12/} Ibid, p. 91

storage. Woodroof of Georgia reported the loss from peaches held at 30° F. and 15° F. to be 10 and 2.7 per cent respectively in 15 days, and 18 and 3.3 per cent in 30 days. He says that about one-fourth as much moisture was lost from quick freezing as slow freezing.^{13/}

Dessication begins on the surface of the product and progresses toward the interior. A firm crust like coating usually develops on all exposed surfaces which acts as a protection against further loss. The use of sugar or syrup reduces dessication markedly, the protection varying with the amount of sugar or the concentration of syrup used. Dessication is most rapid at the beginning of the storage period. If the product is packed in closely filled water tight, or air tight containers, dessication is reduced to a minimum.

- (2) Biological Activity. - "Freezing stimulates biological activity causing a loss of flavor and color in some products, and the development of undesirable flavor and color in others."
- (3) Physical Activity. - Probably the outstanding physical change during freezing regardless of the temperature is expansion. Physical change also occurs in the cell solution. There is the belief that changes in or injury to plant tissues upon freezing is caused by the crushing and piercing action of the ice crystals. However, results of recent research conducted by numerous investigations show this to be untrue.^{14/}

^{13/} Woodroof, J. G., "Experiments in Food Freezing," p. 366. Refrig. Eng., June, 1932.

^{14/} Diehl, H. C., "A Physiological View of Freezing Preservation," p. 661. Ind. and Eng. Chem., Vol. 24, June, 1932.

(4) **Micro-Physical.** - The loss of plant juices, according to Woodroof, is not due to ruptured cells but to the precipitation of cell contents, and that flabbiness is probably due to the breaking down of content of the cells which formerly gave support.^{15/} According to Fellers, of Massachusetts, the cell contents of both plants and animals consist of colloidal gels containing proteins, salts, and water. "When the water is frozen the gel structure or network is broken down. In the case of flesh, the colloidal gel structure is largely reversible and when frozen meats or fish are thawed the cells reabsorb most of the water." "In fruits and vegetables the gel being irreversible, cell walls may rupture."^{16/} It is commonly believed that in the freezing of fruits water in the intercellular spaces freezes first. This freezing has a desiccative effect upon the contents of the cell. Then upon thawing, the juice runs out of the fruit instead of being reabsorbed by the cells.

^{15/} Woodroof, op. cit., p. 366.

^{16/} Fellers, op. cit., p. 607, Contribution 136, 1932.

Summary

Besides getting low prices for their fruit during some seasons enormous losses occur due to small fruit, bruising during handling and transit, leaks, and other defects. Market demands are often so low that much fruit is left unharvested. It has been estimated, in the case of strawberries, that from 10 to 25 per cent of the crop is lost annually due to small, decayed, and otherwise defective fruit.

Low prices received for Tennessee berries are probably a result of improper grading and packing. Too, Tennessee growers do not make a regular practice of mulching their strawberries, and as a result berries are often gritty and dirty. These factors and others have caused growers of this state to receive the lowest price for strawberries of almost any other state in the union.

The seasonal supply of fruit affects the market price. The price varies on individual markets, but is somewhat proportional to supply. The lowest prices received for berries are not necessarily lowest on days having the highest shipments, but usually follow the season of heaviest shipments by some 5 to 15 days. Too, the seasonal price of strawberries and peaches does not increase very rapidly during the latter part of the season when the supply has greatly diminished, due partly to poorer quality of fruit.

It is thought that freezing will offer an outlet for fruit during periods of heavy shipments, particularly when supply of fresh fruit is greater than demand. This additional outlet should tend to stabilize prices of fresh fruit and at the same time increase the total amount consumed.

In the case of some fruits, shipments for distance that will require more than 36 hours in transit are often impractical. For instance,

"young dewberries" are so fragil that the slightest jar often ruptures the skin. Too, the fruit is so soft that the duruplets will often break of their own weight after a few hours standing. Such fruit must be sold on markets close to the producing areas, or frozen.

With modern methods of refrigeration freezing storage at 10° F. and below are quite common. Rates at these low temperatures are not excessive as they usually run about 15 cents per month for freezing storage plus 20 cents extra the first month for handling and freezing.

The more important advantages of freezing are: the improvement in flavor and color of the product over canned fruits and vegetables; the preservation of vitamin content; the utilization of surpluses; and the stabilizing effect it will have on the price of fresh fruit.

Freezing has the disadvantages of requiring refrigerated facilities for storage and transportation and for delaying the turnover of money to the farmer.

CHAPTER III

COLD STORAGE FACILITIESIntroduction

This chapter deals primarily with the extent and location of cold storage facilities in the United States. These are important to the freezing industry because fruit must be frozen relatively close to the producing areas.

The information given in this chapter has been assembled from various secondary sources. The assembling of this available information should give a satisfactory picture from the standpoint of the cold-packer.

Proper Cold Storage Important in the Freezing Process

The freezing of fruits and vegetables is primarily dependent upon adequate cold storage facilities. According to Joslyn, of California:

"The deterioration of fruits and vegetables is caused either by rapid softening and decay brought about by the action of certain ripening enzymes or by the action of molds, yeast and bacteria. The ripening, respiration and normal life processes of the fruit or vegetable and the microorganisms with which they may be infected are most active at certain optimum or favorable temperatures. At lower temperatures the enzyme action and growth of microorganisms are retarded and if the temperature is low enough they may be entirely inhibited. The temperature used will depend upon the desired storage period. At a temperature of 10° F. low enough to freeze the fruit, molding, fermentation, and bacterial spoiling does not occur and the normal ripening and respiration processes are effectively arrested." 1/

1/ Joslyn, M. A., "Preservation of Fruits and Vegetables by Freezing". Calif. Agr. Exp. Sta. Bul. 320 - 1930 - p. 5

"After the fruit mass is frozen, a temperature of 15° to 20° F. has been found satisfactory for long storage".^{2/}

The freezing of fruit should be done at temperatures as low as practical means will afford. According to Woodroof, of Georgia, there are three very important reasons for employing low temperatures in freezing. First, to increase the production of the plant; second, to freeze the fruit before oxidation or other changes occur; third, to more perfectly preserve the structure and color of the fruit tissue.^{3/}

The fact that the freezing of fruits and vegetables calls for adequate freezing and storage facilities makes the location and capacity of refrigerated warehouses a very influencing factor in developing an industry of this kind.

The Refrigerated Warehouse Industry in the United States as a Whole

The total refrigerated warehouse space in the United States as reported October 1, 1933 by 1,299 concerns was approximately 711,941,769 cubic feet, compared with 54,572,892 cubic feet in 1921.^{4/} This shows that the various concerns operating cold storage warehouses expanded their facilities approximately 30.9 per cent during this period. Public cold storage space increased about 63.3 per cent during this time, while private space increased more than 100 per cent (see table XXXII). Another interesting thing is that while the total refrigerated space was increasing rapidly, the number of cold storage concerns increased but very little.

^{2/} Joslyn, M. A., *Op. cit.*, p. 6

^{3/} Woodroof, J. G., "Preserving Fruits by Freezing, I Peaches".
Ga. Exp. Sta. Bul. 163, 1930 - p. 37.

^{4/} "Cold Storage Holdings" - U. S. D. A. Stat. Bul. 48 - 1934 - p. 6.

TABLE XXXII

TOTAL REFRIGERATED WAREHOUSE SPACE AND NUMBER
OF CONCERNS, UNITED STATES 1921-1933

(Index Base, 1921 = 100. Space in thousands of
cubic feet)

<u>Class of Business</u>	<u>1921</u>	<u>1923</u>	<u>1925</u>	<u>1927</u>	<u>1929</u>	<u>1931</u>	<u>1933</u>
Public Storage Concerns	342	369	416	462	517	529	540
Space	194,166	205,935	24,256	273,896	316,810	325,702	317,211
Index of Space	100	106	124.9	141.0	163.1	167.7	163.3
Combined Public & Private Concerns	220	218	212	219	209	209	175
Space	39,743	46,312	57,034	57,275	60,312	58,853	64,717
Index of Space	100	116.5	143.5	144.1	151.7	148.0	162.8
Packing Establishments Doing Public Cold Storage Business							
Concerns	22	27	34	31	29	24	25
Space	35,173	47,630	56,837	66,314	56,065	89,465	43,444
Index of Space	100	135.4	161.5	188.5	159.3	197.4	123.5
Private Cold Storage Concerns	275	307	264	273	270	249	225
Space	15,940	24,076	24,065	24,805	291,326	35,222	32,738
Index of Space	100	151.0	150.9	155.6	182.7	220.9	205.3
Meat Packing Establishments							
Concern	443	433	397	378	375	345	334
Space	258,548	261,448	246,165	245,554	266,264	251,599	253,829
Index of Space	100	101.1	95.2	94.9	102.9	97.3	98.1
Total U. S. Refrigerated Space							
Concern	1302	1354	1323	1363	1400	1356	1299
Space	543,572	595,404	626,667	667,846	728,594	740,843	711,941
Index of Concerns	100	103.9	101.6	104.6	107.5	104.1	99.7
Index of Space	100	107.6	115.2	122.8	134.0	136.2	130.9

Source: "Cold Storage Holdings" - N. S. D. A. Stat. B 43- 1934 - P. 6
(Table 3)

Location of Refrigerated Space in the United States

By States or Groups of States - About 29 per cent of the total refrigerated space in the United States in 1929 was located in the East North Central States, which includes Illinois, Michigan, Indiana, and Ohio. About 22 per cent of the space was in the West North Central States, which includes Missouri, Kansas, Iowa, North and South Dakota, and Wisconsin (see Table XXXII-a.) The leading states are Illinois, New York, Massachusetts, New Jersey, Ohio, Kansas, and Missouri (Figure 27).

The number of concerns operating refrigerated warehouses has not tended to increase since 1925, while refrigerated space increased about 15 per cent. The number of concerns increased from 1925 to 1929, but have showed a decided decrease since 1929 (Table XXXIV).

TABLE XXXII-a

PERCENTAGE DISTRIBUTION OF TOTAL REFRIGERATED
WAREHOUSE SPACE BY REGIONS IN THE UNITED STATES, 1929

<u>Region</u>	<u>Per Cent</u>
East North Central	29
West North Central	22
Middle Atlantic	20
Pacific States	12
South Atlantic	5
New England	4
West South Central	4
Mountain States	2
East South Central	2
Total	100

Source: U. S. D. A. Stat. Bul. 33 - 1931 - (Data calculated)

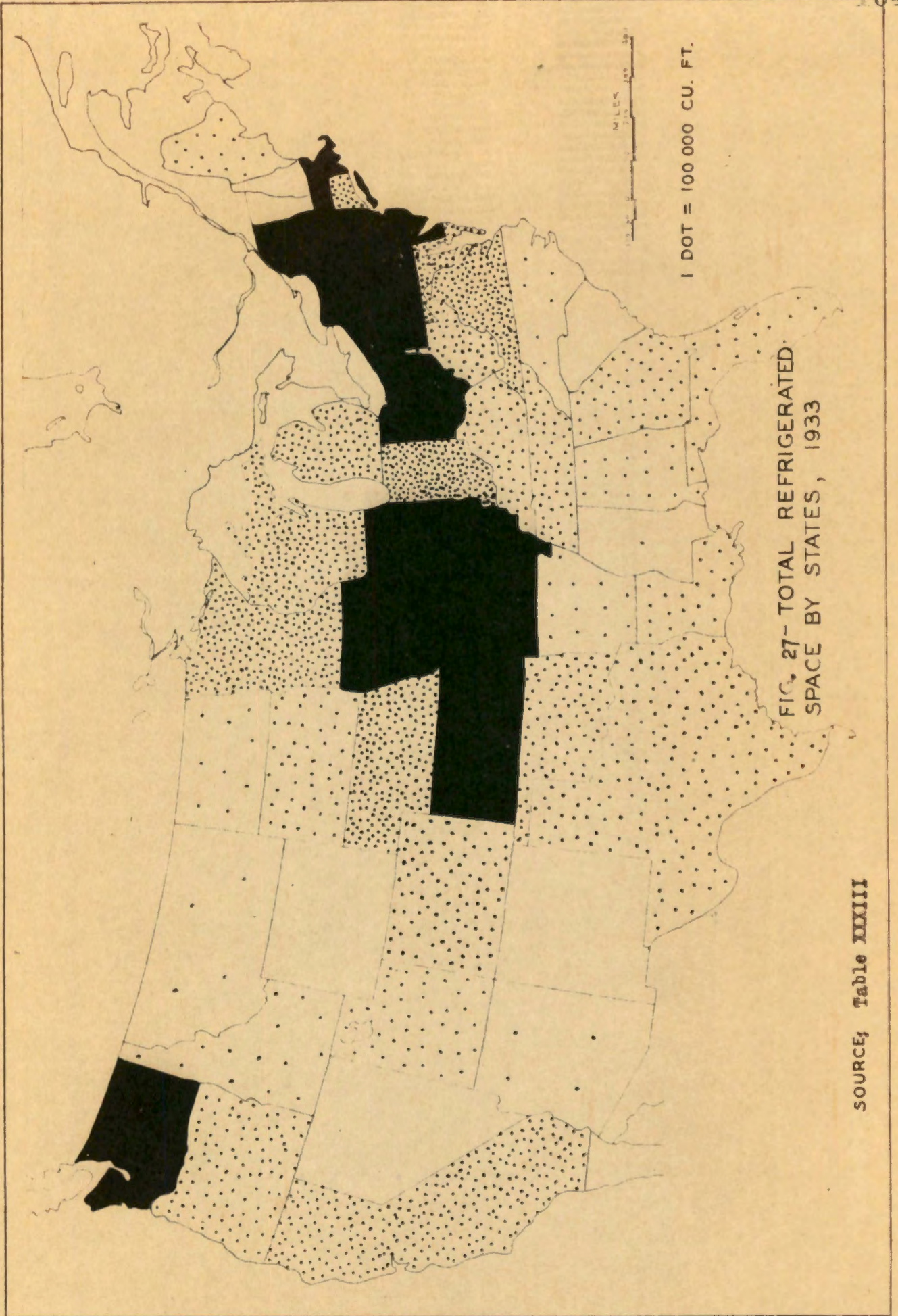


FIG. 27- TOTAL REFRIGERATED SPACE BY STATES, 1933

SOURCE: Table XXXIII

TABLE XXXIII

TOTAL REFRIGERATED SPACE IN THE UNITED STATES

State	(Thousands of cubic feet)		
	1925	1929	1933
Alabama	1,263	1,395	1,675
Alaska	679	1,031	1,109
Arizona	492	--	486
Arkansas	1,436	1,555	1,141
California	21,822	28,513	27,923
Colorado	6,407	7,411	7,610
Connecticut	2,261	1,643	1,572
Delaware	--	685	900
Dist. of Columbia	2,582	2,625	2,095
Florida	786	2,017	2,147
Georgia	2,802	3,883	4,745
Idaho	509	1,436	1,426
Illinois	142,379	130,163	119,503
Indiana	16,687	18,246	17,952
Iowa	23,705	25,850	58,800
Kansas	42,141	44,510	43,242
Kentucky	5,029	5,620	4,899
Louisiana	2,256	2,514	2,152
Maine	1,388	1,214	1,580
Maryland	4,385	5,748	5,354
Massachusetts	23,872	23,395	21,362
Michigan	8,412	16,083	14,222
Minnesota	21,757	30,618	24,920
Mississippi	--	143	74
Missouri	35,819	37,077	34,807
Montana	271	299	381
Nebraska	23,866	21,473	21,848
New Jersey	13,643	22,271	26,589
New York	75,412	90,825	85,582
North Carolina	714	554	550
North Dakota	--	--	874
Ohio	23,437	31,985	29,422
Oklahoma	8,954	7,448	7,964
Oregon	5,717	9,617	10,278
Pennsylvania	25,107	32,480	34,223
Rhode Island	1,553	1,567	1,730
South Dakota	3,699	4,139	4,605
Tennessee	6,048	5,825	5,464
Texas	14,735	15,695	17,909
Utah	1,597	1,637	3,480
Virginia	13,739	17,603	17,690
Washington	20,749	49,528	50,628
West Virginia	3,206	4,947	4,024
Wisconsin	14,404	15,862	16,653
All other States	925	1,444	330
Total	626,667	728,594	711,941

Source: U.S.D.A. - Statistical Bulletin 33, 48

TABLE XXXIV

CONCERNS - OPERATING REFRIGERATED WAREHOUSES 1925-1935

<u>State</u>	<u>1925</u>	<u>1929</u>	<u>1933</u>	<u>1935</u>
Alabama	4	7	5	8
Alaska	5	4	4	--
Arizona	4	--	3	10
Arkansas	7	6	6	13
California	74	72	71	78
Colorado	17	21	16	14
Connecticut	6	8	8	4
Delaware	--	3	5	6
Dist. of Columbia	4	4	3	2
Florida	10	14	12	19
Georgia	19	21	29	29
Idaho	12	13	15	18
Illinois	86	79	71	40
Indiana	42	44	39	20
Iowa	38	36	36	13
Kansas	31	31	32	26
Kentucky	15	15	13	11
Louisiana	7	8	7	14
Maine	8	11	10	2
Maryland	21	17	15	9
Massachusetts	39	38	35	19
Michigan	33	40	33	20
Minnesota	27	27	25	12
Mississippi	--	5	3	--
Missouri	50	50	45	26
Montana	6	6	5	4
Nebraska	19	22	18	12
New Hampshire	--	--	--	1
New Jersey	30	37	36	22
New Mexico	--	--	--	4
New York	180	198	180	139
North Carolina	8	10	10	11
North Dakota	--	--	3	1
Ohio	92	87	75	34
Oklahoma	13	12	10	38
Oregon	29	32	29	39
Pennsylvania	108	96	92	50
Rhode Island	3	4	4	1
South Carolina	--	--	--	1
South Dakota	7	8	5	2
Tennessee	20	20	18	14
Texas	55	50	47	67
Utah	7	7	8	7
Vermont	--	--	--	1
Virginia	28	26	29	33

TABLE XXXIV - continued

CONCERNS - OPERATING REFRIGERATED WAREHOUSES 1925-1935

<u>State</u>	<u>1925</u>	<u>1929</u>	<u>1933</u>	<u>1935</u>
Washington	66	120	111	141
West Virginia	17	17	14	10
Wisconsin	62	60	57	13
All other States	14	14	7	
Total	1,323	1,400	1,299	1,058

Source: List for Jan., 1935, published by--Code Authority on Refrigerated Warehouses. U.S.D.A. - Stat. Bul. 13, 33, and 48.

In Leading Cities. - In 1933, Chicago easily led all the cities in refrigerated space with 106,411,216 cubic feet, or about one-seventh of the space. New York City comes second with 51,160,857 cubic feet; Kansas City, third; and St. Louis, fourth (see Table XXXV). All of these cities have a considerable amount of space at 10° F. and below.

Kind of Refrigerated Space

Total United States. - The refrigerated space in this country may be classified according to the temperature maintained. The recent trend in refrigerated space has been toward lower temperatures. These relatively low temperatures (usually below 15° F.) make it possible to store relatively perishable products with a rather definite degree of safety. From 1925 to 1933 space at 10° F. and below increased approximately 43 per cent, which was more than twice the increase in space held at any other temperature (Table XXXVII).

The private cold storage houses maintain lower temperatures than any other type of cold storage. Private cold storage space maintained about 51.7 per cent of their space at 10° F. and below in 1931 - as compared to 18.1 per cent of the public storage houses.

Space by States. - The New England States have a higher percentage of their refrigerated space at freezing temperatures than any other group of states (Table XXXVII). More than half of the space in this group of states is freezer space (below 32° F.). The West South Central States reported the lowest percentage of freezer space with only 13 per cent.

TABLE XXXV

REFRIGERATED SPACE: LEADING CITIES,
ALL COLD STORAGES AND MEAT-PACKING
ESTABLISHMENTS - OCT. 1, 1933

(Cu. Ft. Space)

	Concerns	10°F & Below	11°-29° F	Total ^{1/}
Baltimore, Md.	13	659,966	276,424	4,945,535
Boston, Mass.	7	5,505,753	359,127	16,436,270
Buffalo, N. Y.	12	2,179,491	686,987	9,801,263
Chicago, Ill.	43	17,036,244	23,662,353	106,411,216
Cincinnati, Ohio	14	763,294	387,120	6,195,176
Cleveland, Ohio	14	2,461,983	739,400	13,802,429
Dallas & Fort Worth, Texas	12	1,867,929	433,924	12,644,655
Denver, Colo.	7	1,086,550	756,730	6,342,698
Detroit, Mich.	11	2,074,220	510,451	12,087,671
Green Bay, Wis.	9	141,959	505,174	2,473,984
Kansas City, Mo. & Kan.	11	4,554,185	2,699,934	36,695,206
Los Angeles, Calif.	14	621,158	749,593	10,771,068
Marshfield, Wis.	4	22,450	---	312,202
Milwaukee, Wis.	10	936,967	920,644	5,588,085
Minneapolis & St. Paul, Minn.	14	2,661,767	1,623,569	17,121,090
Greater New York	61	11,538,426	4,334,668	51,160,857
Omaha, Neb.	9	3,231,101	1,110,357	20,570,959
Philadelphia, Penna.	21	3,113,624	1,485,505	13,689,217
Providence, R. I.	3	234,053	7,200	1,483,529
Portland, Ore.	9	1,078,308	597,234	4,957,047
Pittsburgh, Penna.	12	1,047,048	1,404,539	8,694,377
San Francisco, Calif.	10	1,240,624	702,902	6,792,167
St. Louis, Mo. & Ill.	18	4,377,925	951,058	21,448,413
Syracuse, N. Y.	6	790,984	52,444	2,792,931
Seattle, Wash.	16	1,471,255	1,212,611	6,817,122
Total	359	70,697,264	46,171,948	400,035,167

Source: U.S.D.A. Stat. Bul. 48 - p. 7 - Table 12.

^{1/} Includes space above 29°F.

TABLE XXXVI

REFRIGERATED SPACE: LEADING CITIES,
PUBLIC COLD STORAGE, OCT. 1, 1933

	Concerns	Space Cu. Ft.		Total Space ^{1/}
		10°F & Below	11°-29° F	
Buffalo, New York	3	1,578,562	335,622	4,299,911
Chicago, Illinois	10	9,145,351	757,064	31,643,239
Cincinnati, Ohio	4	691,304	362,940	3,190,016
Dallas & Fort Worth, Texas	7	966,405	26,856	3,283,222
Detroit, Michigan	7	1,856,854	243,504	8,172,968
Kansas City, Mo., & Kan.	3	1,481,585	---	4,753,062
Los Angeles, Calif.	6	507,634	546,937	6,940,046
Milwaukee, Wisconsin	3	550,509	600,000	2,143,790
Minneapolis & St. Paul, Minn.	6	1,160,773	363,352	3,208,457
Greater, New York	29	10,517,737	3,488,113	40,166,884
Philadelphia, Penna.	8	2,546,566	1,230,172	10,154,294
Portland, Oregon	5	937,694	427,309	3,411,923
Pittsburgh, Penna.	6	1,029,474	1,355,599	6,008,234
St. Louis, Mo., & Ill.	6	3,027,800	197,661	9,573,921
Seattle, Washington	6	1,277,995	566,027	4,594,349
Cleveland, Ohio	5	2,319,483	616,706	10,672,811
Total	114	39,592,726	11,178,662	152,217,127

Source: U.S.D.A. Stat. Bul. 48, 1934 - p. 6. Table 10.

^{1/} Includes space above 29°F.

TABLE XXXVII

CHANGE IN REFRIGERATED SPACE HELD AT DIFFERENT
TEMPERATURES IN UNITED STATES - 1925-1933

Year	Cubic Feet of Space Held at Temperatures of:				
	10 F & Below	11 to 29 F Inclusive	30 to 44 F Inclusive	45 F & Above	Total Space
1925	68,721,782	59,414,433	462,012,398	36,519,137	626,667,750
1929	94,785,822	75,780,605	520,009,695	38,018,716	728,594,833
1933	98,314,447	71,438,106	502,468,828	39,720,588	711,941,769
		Index of Space:			
1925	100.0	100.0	100.0	100.0	100.0
1927	137.9	127.5	112.5	104.1	116.2
1933	143.0	120.2	108.7	108.7	113.6

Source: U. S. D. A. Stat. Buls, 13, 33, and 48 - pages 6, 6, 5 respectively

Base of Index on 1925 = 100

Illinois, New York, Massachusetts, and New Jersey reported more space at 10° F. and below in 1929 than other states (Figure 28). In 1933 we find these same states leading in space held at 10° F. and below.

TABLE XXXVIII

PER CENT OF REFRIGERATED SPACE HELD AT
FREEZING AND AT HIGHER TEMPERATURES - 1929

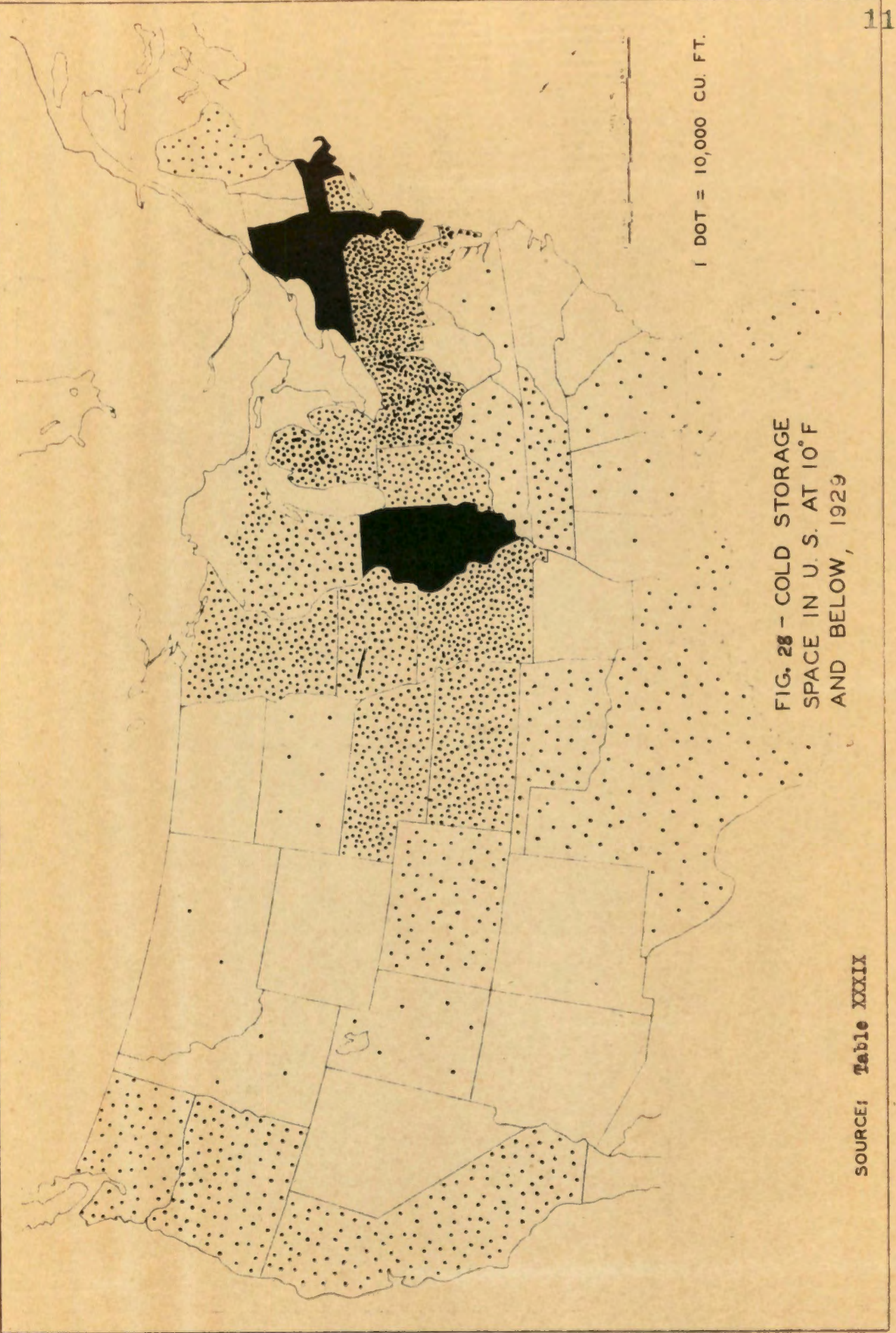
<u>Region</u>	<u>Per Cent Freezer^{1/} Space</u>	<u>Per Cent Cooler Space</u>
New England	53	47
South Atlantic	15	85
West South Central	13	87
East South Central	21	79
East North Central	29	71
West North Central	31	79
Middle Atlantic States	26	74
Mountain States	32	68
Pacific States	19	81

Source: U. S. D. A. Stat. Bul. 33 - 1931 (Percentages calculated)

^{1/} Freezer space represents space below 32° F.

Cold Storage Facilities in Tennessee and Surrounding States

Concerns with Refrigerating Equipment for Ice and Storage. - In 1935 approximately 133 concerns were engaged in operating ice and cold storage houses in Tennessee (Table XLI). Most of these concerns were located in or near Memphis, Nashville, Chattanooga, and Knoxville (Figure 29). Of course only a few of the ice plants and cold storage houses of Tennessee have sufficient refrigeration or insulation for freezing, but their facilities might be improved to a point where they could be used for



1 DOT = 10,000 CU. FT.

FIG. 28 - COLD STORAGE SPACE IN U. S. AT 10° F AND BELOW, 1929

SOURCE: Table XXXIX

TABLE XXXIX

TOTAL REFRIGERATED SPACE: ALL COLD STORAGES, INCLUDING
MEAT-PACKING ESTABLISHMENTS REPORTED TO THE BUR. OF AGR. ECON. OCT. 1, 1929
(Preserving Foodstuffs by Quick Freezing and Refrigeration)

State	Number Concerns	10° F & Below Cu.Ft.	10°-29° F Cu.Ft.	30°-44° F Cu.Ft.	45° F & Above Cu.Ft.	Total Space
Alabama	7	140,000	50,604	1,149,091	55,822	1,395,517
Alaska	4	487,822	535,892	7,776	---	1,031,490
Arkansas	6	5,600	57,760	1,442,400	50,000	1,555,760
California	72	2,237,462	1,933,894	23,554,542	787,473	28,513,371
Colorado	21	1,147,411	855,162	4,902,612	506,405	7,411,590
Connecticut	8	278,000	96,350	1,123,305	146,000	1,643,655
Delaware	3	78,000	9,650	526,461	71,701	685,812
District of Columbia	4	298,244	1,081,984	1,196,235	48,966	2,625,429
Florida	14	291,050	167,780	1,383,936	174,372	2,017,138
Georgia	21	249,948	332,760	3,196,143	104,609	3,883,460
Idaho	13	56,831	118,270	1,132,259	128,956	1,436,317
Illinois	79	20,733,119	27,268,317	73,599,703	8,562,049	13,163,186
Maryland	44	1,735,881	1,158,130	14,292,523	1,059,694	18,246,228
Iowa	36	2,584,252	2,540,195	18,767,650	1,958,118	25,850,215
Kansas	31	3,686,907	3,400,131	31,364,928	6,058,715	44,510,681
Kentucky	15	353,515	422,208	4,801,036	45,814	5,620,573
Louisiana	8	293,886	48,589	2,171,623	---	2,514,098
Maine	11	607,337	66,750	535,705	4,907	1,214,699
Maryland	17	655,544	685,982	4,170,907	236,376	5,748,809
Massachusetts	38	8,231,612	628,757	14,527,885	7,584	23,393,838
Michigan	40	3,268,275	1,900,175	10,874,449	40,497	16,083,396
Minnesota	27	4,157,172	2,770,126	20,552,867	3,438,502	30,618,667
Mississippi	5	21,456	23,470	75,200	23,455	143,581

TABLE XXXIX (Continued)

State	Number Concerns	10° F & Below		10°-29° F		30°-44° F		45° F & Above		Total Space
		Cu.Ft.	Cu.Ft.	Cu.Ft.	Cu.Ft.	Cu.Ft.	Cu.Ft.	Cu.Ft.	Cu.Ft.	
Missouri	50	4,975,161	2,902,329	28,038,332	1,157,505	37,077,327				
Montana	6	23,583	54,050	212,541	9,540	299,714				
Nebraska	22	3,420,438	2,385,775	14,648,520	1,018,597	21,473,330				
New Jersey	37	4,865,881	1,413,053	14,961,988	1,030,111	22,271,033				
New York	198	12,916,321	5,250,392	70,037,873	2,620,789	90,825,375				
North Carolina	10	--	75,342	358,987	119,960	554,289				
Ohio	87	4,561,743	3,085,442	23,410,759	927,887	31,985,831				
Oklahoma	12	384,376	1,109,561	4,999,684	955,240	7,448,861				
Oregon	32	1,670,420	1,506,225	6,224,479	196,027	9,617,151				
Pennsylvania	96	4,866,716	3,032,174	24,170,186	411,150	32,480,226				
Rhode Island	4	338,168	406,000	822,928	--	1,567,096				
South Dakota	8	127,350	475,610	2,884,674	651,499	4,139,137				
Tennessee	20	814,258	419,066	4,378,019	214,391	5,825,734				
Texas	50	1,179,884	1,034,132	11,976,686	1,504,693	15,695,395				
Utah	7	143,641	196,854	1,271,048	26,112	1,637,655				
Virginia	26	88,060	1,089,454	16,404,903	21,400	17,603,817				
Washington	120	1,199,532	3,842,771	42,124,296	2,362,381	49,528,980				
West Virginia	17	4,000	90,051	4,811,893	4,841,996	4,947,940				
Wisconsin	60	1,558,218	888,007	12,255,219	1,161,121	15,862,565				
All Other States	14	44,744	371,670	947,439	80,302	1,444,155				
Total	1,400	94,785,822	75,780,605	520,009,690	38,018,716	728,594,833				

Source: U. S. D. A. Stat. Bul. 33, 1931, p. 6.

TABLE XL

TOTAL REFRIGERATED SPACE: ALL COLD STORAGES,
INCLUDING MEAT-PACKING ESTABLISHMENTS, REPORTING TO THE
BUREAU OF AGRICULTURAL ECONOMICS, OCT. 1, 1933

	Concerns	10°F & Below	11°-29° F	Total ^{1/}
Alabama	5	146,300	29,500	1,675,353
Alaska	4	984,381	125,157	1,109,538
Arizona	3	---	45,924	486,075
Arkansas	6	4,750	45,360	1,141,538
California	71	2,563,911	1,825,745	27,923,995
Colorado	16	1,243,878	796,446	7,610,061
Connecticut	8	224,225	55,160	1,572,045
Delaware	5	79,800	468,888	900,560
District of Columbia	3	350,220	303,418	2,095,601
Florida	12	328,283	303,418	2,147,806
Georgia	29	729,546	185,220	475,514
Idaho	15	160,196	165,000	1,426,498
Illinois	71	18,185,860	24,293,530	119,503,474
Indiana	39	1,407,162	1,395,259	17,952,059
Iowa	36	3,279,024	3,019,466	28,800,961
Kansas	32	4,763,858	3,907,387	43,242,745
Kentucky	13	445,950	284,017	4,899,147
Louisiana	7	311,147	10,100	2,152,152
Maine	10	725,211	24,021	1,580,598
Maryland	15	674,966	361,424	5,354,201
Massachusetts	35	7,056,896	702,252	21,362,295
Michigan	33	2,383,150	851,925	14,222,715
Minnesota	25	4,113,559	2,419,697	24,920,228
Mississippi	3	16,130	15,598	74,168
Missouri	45	6,493,110	1,511,030	34,807,407
Montana	5	42,984	52,372	381,975
Nebraska	18	3,581,014	1,274,454	21,848,845
New Jersey	36	4,891,484	3,345,948	26,589,036
New York	180	12,635,816	4,972,160	85,582,010
North Carolina	10	55,470	36,858	550,669
North Dakota	3	209,493	28,074	874,507
Ohio	75	4,231,315	1,764,752	29,422,188
Oklahoma	10	592,604	789,603	7,964,178
Oregon	29	1,535,297	1,138,088	10,278,284
Pennsylvania	92	4,940,663	3,928,941	34,223,841
Rhode Island	4	234,053	7,200	1,730,270
South Dakota	5	157,130	1,676,578	4,605,043
Tennessee	18	987,023	149,628	5,465,354
Texas	47	2,164,929	757,297	17,909,875
Utah	8	482,632	1,078,803	3,480,863
Virginia	29	391,570	869,910	17,690,810
Washington	111	2,682,652	4,308,750	50,628,651
West Virginia	14	3,000	15,519	4,024,748
Wisconsin	57	1,813,233	2,377,398	16,653,482
All Other	7	10,572	24,249	330,406
Total	1,299	98,314,447	71,438,106	711,941,769

Source: U.S.D.A. Stat. Bul. 48.

^{1/} Totals includes space at higher temperatures.

freezing. Only 14 of these 133 concerns reported commercial cold storage holdings, according to the mailing list of the Code Authority in 1935 (Figure 30).

TABLE XLI

LOCATION OF CONCERNS OPERATING ICE HOUSES,
AND COLD STORAGE WAREHOUSES IN TENNESSEE 1935 ^{1/}

<u>Town</u>	<u>County</u>	<u>Company</u>
Alcoa	Blount	Blount County Ice Company
Athens	McMinn	Tenn. Electric Power Company
Bolivar	Hardeman	Bear Ice Co., of Jackson
Brownsville	Haywood	Tenn. Power & Light Co.
Bruceton	Carroll	
Centerville	Hickman	
Chattanooga	Hamilton	Tenn. Service Corporation
"	"	Arrow Trans. & Storage Company
"	"	Pure Ice Company
"	"	Atlantic Ice and Coal Company
"	"	American Service Company
"	"	Citizen's Ice Company
"	"	Chattanooga Ice Del. Company
"	"	Martin Bros. Ice Company
"	"	Old Hickory Ice Company
"	"	Gorce Ice Mfg. Company
"	"	Rossville Ice Company
"	"	Volunteer Ice Company
Clarksville	Montgomery	Manning-Orgain Supply Company
"	"	Radabough-Corbitt Company
Cleveland	Bradley	Southera Cold Storage Company
"	"	City Ice & Coal Company
Clifton	Wayne	Clifton Ice & Coal Company, Inc.
Clinton	Anderson	Tennessee Electric Power Company
Columbia	Maury	Columbia Ice & Coal Company
Crossville	Cumberland	Ice Plant
Dickson	Dickson	Ice Plant
"	"	Ice Plant
Dyersburg	Dyer	2 Ice Factories
Erin	Houston	
Etowah	McMinn	Etowah Coal & Ice Company
Fayetteville	Lincoln	Tenn. Electric Power Company
Greenville	Greene	Greenville Ice Company
Harriman	Roane	Enterprise Ice & Coal Company
Hartsville	Trousdale	
Henderson	Chester	Oscar Foy & Son

TABLE XLI (Continued)

LOCATION OF CONCERNS OPERATING ICE HOUSES,
AND COLD STORAGE WAREHOUSES IN TENNESSEE 1935 ^{1/}

<u>Town</u>	<u>County</u>	<u>Company</u>
Memphis	Shelby	Porter Ice & Coal Company
"	"	Old Hickory Ice & Coal Company
"	"	Railways Ice Company
"	"	Allied Service, Inc.
"	"	Standard Ice Company
Milan	Gibson	Milan Ice & Fuel Company
"	"	Wilson Ice & Fuel Company
Morristown	Hamblin	Morristown Prod. & Ice Corp.
"	"	Hamblin County Ice Corp.
Mt. Pleasant	Maury	Mt. Pleasant Ice Company
Murfeesboro	Rutherford	
Nashville	Davidson	Noel & Company
"	"	Atlantic Ice & Coal Co., Plant #1
"	"	" " " " " " " #2
"	"	Roberson Bros. Ice & Coal Company
"	"	Reynolds, J. O. & Son
"	"	Old Hickory Ice & Coal Company
"	"	Polar Ice Company
"	"	Old Hickory Ice Company
"	"	Home Ice & Coal Company
"	"	Meadors, Vaughn, & Hollan
"	"	Howe, John B.
"	"	Dixie Ice & Fruit Company
"	"	Cumberland Ice Company
"	"	Vester, J. F. & Sons
"	"	Hermitage Ice Company
Newport	Cocke	Newport Ice Company
Obion	Obion	Obion Ice Company
Old Hickory	Davidson	Old Hickory Coal & Ice Company
Paris	Henry	Ky. & Tenn. Light & Power Company
"	"	People's Coal & Ice Company
Pikeville	Bledsoe	Tenn. Elec. Power Company
Pulaski	Giles	T. M. Booth & Son
"	"	City Ice Delivery Company
"	"	Pulaski Ice & Storage Company
Rockwood	Roane	Rockwood Ice & Coal Company
Selmer	McNairy	Selmer Ice Company
Sevierville	Sevier	Sevierville Ice Company
Shelbyville	Bedford	
South Pittsburgh	Marion	
Sparta	White	Lee Ice Company
Springfield	Robertson	Gregory Coal & Ice Company

TABLE XLI (Continued)

LOCATION OF CONCERNS OPERATING ICE HOUSES,
AND COLD STORAGE WAREHOUSES IN TENNESSEE 1935

<u>Town</u>	<u>County</u>	<u>Company</u>
Henning	Lauderdale	Henning Ice & Coal Company
Hohenwald	Lewis	Hohenwald Ice Company
Humboldt	Gibson	Humboldt Storage Company
Huntingdon	Carroll	Huntingdon Ice Company
Jackson	Madison	Beare Ice & Coal Company, Plant #1
"	"	" " " " " " " " #2
"	"	" " " " " " " " #4
Johnson City	Washington	Jackson Ice & Coal Company
Jonesboro	"	Walker Coal & Ice Company
Kenton	Obion	M. T. Lytle & Roy Cload
Knoxville	Knox	Kurton Ice Company
"	"	Atlantic Ice & Coal Company
"	"	Knoxville Ice & Coal Company
"	"	Western Avenue Coal Storage Company
"	"	B. T. Ice Company
"	"	East Tenn. Packing Company
"	"	Morgan Ice & Coal Company
"	"	North Star Ice & Fuel Company
Lawrenceburg	Lawrence	Harlan Ice Company
Lenoir City	Loudon	Thompson Ice Company
"	"	Tenn. Electric Power Company
Lewisburg	Marshall	New Ice & Coal Company
"	"	Sims Ice Company
Lexington	Henderson	City Ice & Coal Company
Lynnville	Giles	Lynnville Roller Mill
Manchester	Coffee	Riddle Ice & Coal Company
Martin	Weakly	Ky-Tenn. Light & Power Company
Maryville	Blount	Maryville Ice & Coal Company
McKenzie	Carroll	McKenzie Ice Company
Memphis	Shelby	Commercial Cold Storage Company
"	"	Bannon Ice & Storage Company
"	"	Bluff City Delivery Company
"	"	Blumenfield Ice & Coal Company
"	"	Broadway Coal & Ice Company
"	"	Consumer's Coal & Ice Company
"	"	Davis Coal & Ice Company
"	"	East End Ice & Coal Company
"	"	Hollywood Ice & Coal Company
"	"	Electric Ice Company (2 Plants)
"	"	North Side Ice Company
"	"	Kay Ice & Coal Company
"	"	Memphis Cold Storage & Warehs. Co.

TABLE XLI - continued
LOCATION OF CONCERNS OPERATING ICE HOUSES
AND COLD STORAGE WAREHOUSES IN TENNESSEE 1935 1

<u>Town</u>	<u>County</u>	<u>Company</u>
Sweetwater	Monroe	Sweetwater Ice & Fuel Company
Trenton	Gibson	Everett Ice Company
Tullahoma	Coffee	Tullahoma Ice & Coal Company
Union City	Obion	McAdeo Ice Company
" "	"	Citizen's Ice Company
Waverly	Humphreys	
Winchester	Franklin	Crystal Ice Company
Woodburg	Cannon	" " "

1 / Source: Telephone Directories, Code Authority Mailing List,
Special Questionnaires - Compiled by Mack Tucker, TVA

Freezing Storage in Tennessee

Freezing storage facilities are available in Chattanooga, Nashville, Memphis, and to a limited extent in Knoxville. Nashville has, by far, more space 10° F. and below than any of the other cities (See Table XLIV).

The cities reporting freezer space are relatively close to one or more large strawberry producing country. Therefore, in freezing, fruit growers could pack the fruit in barrels before hauling it in to the storage house, or they could haul the fruit to town before packing it.

TABLE XLIII

REFRIGERATED SPACE IN TENNESSEE -

SUMMARY BY CLASS OF BUSINESS, OCTOBER 1, 1931

SPACE (1000 CU. FT.)

<u>Class Business</u>	<u>Concerns</u>	<u>10° F. & Per</u> <u>Below Cent</u>	<u>11-29° Per</u> <u>F. Cent</u>	<u>30-44° Per</u> <u>F. Cent</u>	<u>45° F. & Per</u> <u>Above Cent</u>
Total Space	19	957 18.1	73 1.4	4105 77.5	156 3.0
Meat Packing Estab.	3	89 7.7	(2) 0	925 79.8	144 12.5
Private C. S.	5	103 51.7	5 2.7	91 45.6	(2) 0
Public C. S.	7	760 20.9	20 .6	2836 78.2	12 0.3
Combined Public & Private	3	5 3.0	0	161 97.0	(2)

Source: Inventory of Facilities for Communication, Storage and Distribution in Tennessee - G. L. Anderson - Bur. Ag. Ec. Exp. Sta., U. of T., P. 257

In 1931, 19 concerns reported refrigerated warehouse space in Tennessee - seven of these concerns operated public cold storage space.

TABLE XLIV

REFRIGERATED SPACE IN TENNESSEE AT 10° F AND BELOW

<u>City</u>	<u>Company Reporting</u>	<u>Cu. Ft. Space</u>
Knoxville	Atlantic Ice and Coal Company	10,000
	East Tennessee Packing Company	12,800
Chattanooga	Arrow Transfer and Storage Company	42,400
	Atlantic Ice and Coal Company	11,360
Nashville	Atlantic Ice and Coal Company	28,072
	Nashville Cold Storage Company	163,662
	Noel and Company	474,000
Memphis	Memphis Cold Storage Warehouse Co.	169,977
	Memphis Packing Company	60,216

Information supplied by U. S. D. A., Bureau of Agr. Economics
1935 - in form of letter

Cold Storage Holdings of Frozen and Preserved Fruits

The largest percentage of holdings in cold storage is reported from the East North Central States, with most of the frozen fruits being held in the Middle Atlantic States (Table XLV and Figure 31)

The Pacific Northwest begins placing her cold pack fruit in storage in July - and usually has the pack completed before the last of August (Table LVII). Too, during July the last North Central States, the South Atlantic, and mountain states begin packing. As a general rule, all packing is over by the middle or last of September as indicated by the decrease in total holdings.

The seasonal trend in holdings of frozen and preserved fruits shows the total holding to be lowest in May and June. This has been invariably true since 1929 (Figure 32).

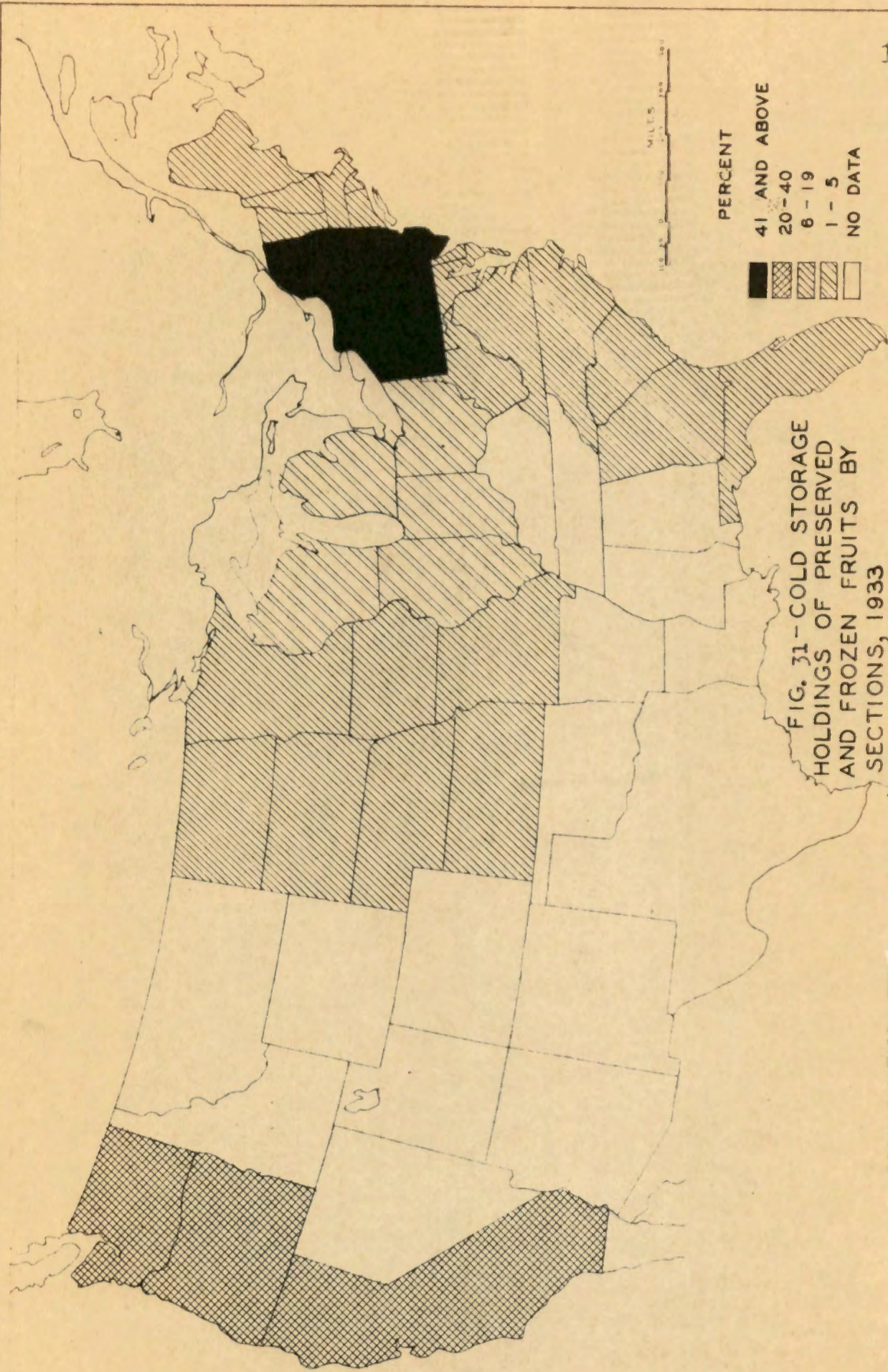


FIG. 31 - COLD STORAGE HOLDINGS OF PRESERVED AND FROZEN FRUITS BY SECTIONS, 1933

SOURCE: Table XLV

TABLE XLV
 COLD-STORAGE STOCKS OF COMMODITIES ON THE FIRST OF THE MONTH OF HEAVIEST HOLDINGS
 BY GEOGRAPHICAL DIVISIONS, 1933

	New England	Middle Atlantic	E. North Central	W. North Central	South Atlantic	E. South Central	W. South Central	Mountain	Pacific
Apples	5	25	8	4	12	-	1	1	44
Frozen Preserved Fruit	5	42	18	3	4	-	1	-	27
Butter	7	21	35	23	1	3	2	2	6
Shell Eggs	3	28	35	17	2	3	3	1	8
Frozen Eggs	4	22	30	29	3	2	5	-	5
Poultry	9	40	25	19	1	1	-	-	5
Beef	9	13	41	33	2	-	6	-	3
Pork	2	5	39	44	2	1	3	2	2
L. and Mutton	14	32	27	17	-	-	-	1	9
Meats total	2	6	38	44	2	1	3	2	2
Lard	5	4	68	17	-	1	1	2	2
Cheese	4	26	55	3	-	-	-	3	5

Source: U. S. D. A. Statistical Bulletin 48, 1934--p. 2.

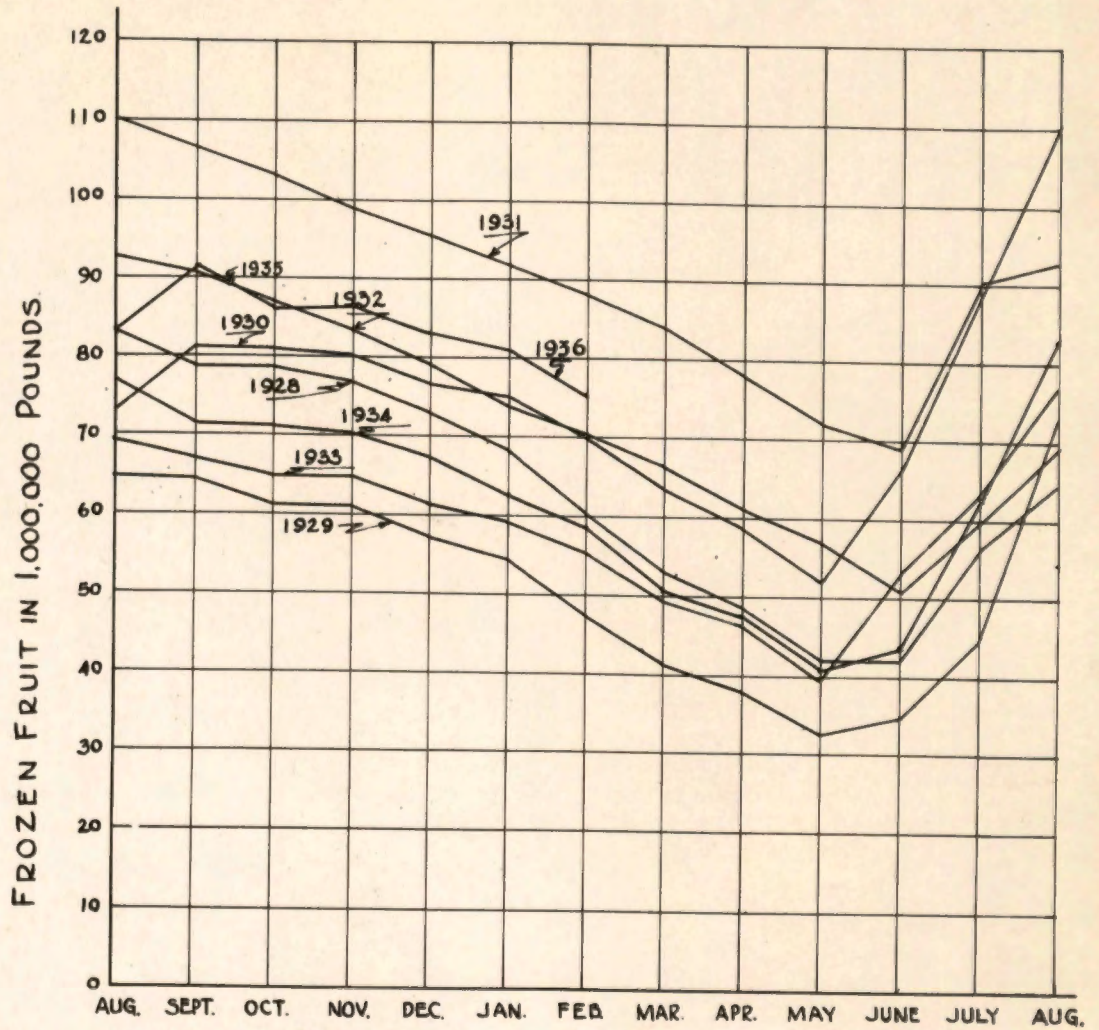
TABLE XLVI

GOLD STORAGE STOCKS

BY GEOGRAPHICAL DIVISIONS FOR 1929

	New England		Middle Atlantic		E. North Central		W. North Central		South Atlantic		E. South Central		W. South Central		Mountain Pacific	
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Apples	2	22	12	6	15	1	1	2	1	1	1	1	2	1	1	39
Creamery Butter	11	26	50	22	1	3	2	2	1	1	3	2	2	1	1	4
Cheese	4	31	46	3	4	2	4	1	2	2	2	1	2	2	2	5
Case Eggs	5	29	30	18	2	4	2	3	2	4	3	3	3	1	1	8
Frozen Eggs	2	22	31	29	2	2	2	2	2	3	3	5	2	5	2	6
Poultry	8	42	31	12	-	1	-	2	-	1	1	2	7	-	-	4
Beef	2	20	48	19	1	1	1	1	1	1	-	2	2	1	1	2
Pork	4	6	40	40	3	3	3	40	3	1	1	2	2	2	2	2
Lamb and Mutton	11	45	22	19	-	-	-	19	-	-	-	1	2	2	2	2
Meats (Total)	4	7	40	40	3	3	3	40	3	3	3	2	2	2	2	2
Lard	7	6	65	16	1	1	1	16	1	1	1	-	-	-	-	3

Source: U. S. D. A. Statistical Bulletin 33, 1929, p. 3, Table 1.



SOURCE: Table XLVII

FIG. 32

**COLD STORAGE HOLDINGS
OF
FROZEN FRUIT
1928 - 1936**

TABLE XLVII
COLD STORAGE HOLDINGS OF FROZEN AND
PRESERVED FRUITS 1925-1935

(Thousand pounds; 000 Omitted)

Month	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
January	34,610	24,054	50,773	54,661	68,725	54,942	74,845	92,305	74,595	59,926	62,769
February	33,827	21,592	48,921	52,196	60,216	48,085	70,646	88,819	70,184	55,434	58,281
March	21,758	19,124	45,716	43,945	53,310	41,723	66,636	82,283	63,613	49,164	50,540
April	19,810	16,368	43,455	40,157	48,570	38,554	60,822	78,162	58,983	46,180	47,749
May	17,016	13,370	39,147	36,659	41,592	32,535	56,740	72,194	51,861	39,993	40,929
June	19,168	23,347	41,075	38,372	42,285	35,854	66,358	69,068	51,922	53,512	43,840
July	24,259	39,421	57,670	60,916	56,539	44,795	88,979	90,323	60,029	63,614	62,638
August	28,702	50,941	62,976	83,228	64,863	73,360	110,223	92,717	69,275	76,056	82,364
September	28,356	59,825	65,352	79,211	64,993	81,734	107,271	91,908	67,631	71,536	91,373
October	25,564	57,990	62,412	79,457	61,548	81,178	103,427	87,302	64,877	71,134	85,912
November	24,640	56,088	61,840	77,274	61,752	80,049	99,234	83,579	65,088	70,316	86,575
December	22,624	54,189	56,971	73,195	57,860	76,737	96,074	79,651	61,713	67,712	83,284

Source: Summary of Cold Storage Holdings--1929, to 1936 inclusive--Crops and Markets.

Summary

At low temperatures the enzyme action and growth of micro-organisms are retarded, and if the temperature is low enough they may be entirely inhibited.

The freezing of fruits and vegetables is primarily dependent upon cold storage facilities, which makes the location and capacity of refrigerated warehouses very important in developing this type of industry.

Since 1921 - refrigerated space in the United States has increased from 543,572, 892 cubic feet to 711,941,769 cubic feet or about 31 per cent. Public cold storage space increased about 63.3 per cent during this time, and private cold storage space slightly over 100 per cent. In 1933, the leading states in refrigerated space in order of importance were: Illinois, New York, Iowa, Washington, Kansas, Missouri, and Pennsylvania. In Illinois, New York, Iowa, Kansas, and Missouri, probably most of the space is used for the storage of meat, butter, eggs, and poultry, while in Washington most of the space is used for apples. The leading cities in refrigerated space are Chicago, New York, Boston, Kansas City, St. Louis, Omaha, Philadelphia, Cleveland, and Cincinnati.

The recent trend in refrigerated space has been an increase in space at lower temperatures. From 1925 to 1933 refrigerated space held at 10° F. and below, increased 43 per cent, which was more than twice as great an increase as was seen in space at any of the other temperatures. Most of the refrigerated space in the United States, however, is held at temperatures from 30° to 44° F.

In Tennessee, cold storage facilities suitable for freezing and storage of fruits are available in Chattanooga, Nashville, and Memphis, and only to a limited extent in Knoxville.

As a general rule most of the cold-pack fruit is frozen and stored in July and August, with some being stored in June. Louisiana, Alabama, and Tennessee place most of their cold-pack fruit in storage in May and the early part of June.

CHAPTER IV

COST OF FREEZING FRUITIntroduction

When a new product is to be produced probably the first and most logical step to take is a preliminary look at costs of production and distribution. First among the elements in cost comes raw materials. Following raw materials comes direct and indirect expenses. The direct expenses include the cost of labor superintendency, fuel, lights, and repairs. The indirect expenses includes such items as taxes, insurance, and depreciation. Too, the containers for the product must be purchased and filled.

The estimates given in this report are taken from various sources, but they compare favorably in most respects. Much of the information presented in this chapter is based on a strawberry freezing experiment conducted by the Tennessee Valley Authority in 1935. These results are compared with costs in other sections of the country.

In all of these analyses the cost of fruit was not included, except in West Tennessee. These estimates have been made on the basis of what it would cost growers to pack their own fruit cooperatively.

The Elements of Cost

Operations. - To determine the cost of freezing, storing, and distributing the cold packed fruit, one must know the labor requirements for every job in each operation, and the wage rate. In freezing the overhead is usually lower when the fruit is frozen cooperatively, as farmers can do much of their own supervising.

The present methods of packing fruits and vegetables have become somewhat standardized. Naturally, the growth of the industry is dependent, to a considerable extent, upon the cost of production. Before any product can be manufactured profitably cost of production must be low enough to compete with similar products or low enough to attract consumers.

The operations in packing consist of the following: Capping the berries, washing, inspection of the fruit, grading, filling of the containers, adding of sugar, weighing of containers, sealing containers, and labeling. Once the fruit has been packed in the containers (usually barrels) it is transported to the nearest cold storage house for freezing. While freezing the barrels should be inverted several times.

In some sections fruit is purchased already capped. This increases the growers' revenue slightly, and is less expensive for the packer. Prominent strawberry growers of East Tennessee has said that they can get the strawberries capped on the farm for 25 cents per crate. The capping of strawberries on the farm brings up the problem of deterioration, and its consequent effect on costs. Strawberries begin to deteriorate as soon as they are picked whether they have been capped or not. However, capped berries deteriorate much faster than uncapped fruit. From opinions of fruit men, capped fruit should not stand for more than 8 or 10 hours before it is packed, even in the shade. However, capped fruit could be held at 35°F. to 40°F. for 24 to 36 hours as easy as fruit for 8 hours at room temperatures of 70 or 80 degrees fahrenheit. To get around part of the deterioration problem, growers can place their fruit in the shade as soon as it has been picked and capped, where it should remain until it is hauled to the packing plant.

When capped, strawberries are delivered to the packing plant

they should be inspected as to variety, maturity, and deterioration. If accepted, the fruit should be placed in a cool room at 35°F. to 40°F., if such a room is available. However, under most conditions a cool room will not be available. When stored at room temperature, the fruit should not be allowed to stand long enough to start mold or leaking.

Labor Costs. - Labor is one of the costs in cold-packing that is comparatively variable because the workers must become skilled before they can be most efficient, and, too, wages vary in different localities. For instance, in the East South Central States the wages in July for 1933, 1934, and 1935, for farm labor, were below one dollar per day, compared with about two dollars in New England (Table XLVIII). Therefore, if farm labor was used in cold-packing, the labor costs would be much lower, assuming the same rate of efficiency, if packing were done in the South. In either case, the expense of capping may be controlled by paying the cappers on a unit basis.

TABLE XLVIII

AVERAGE WAGE PAID TO HIRED FARM LABOR
July 1933, 1934, 1935
(per day, without board)

<u>States Group</u>	<u>1933</u>	<u>1934</u>	<u>1935</u>
New England	\$1.96	\$2.27	\$2.31
Middle Atlantic	1.73	1.95	2.01
East North Central	1.31	1.43	1.62
West North Central	1.27	1.41	1.65
South Atlantic	.79	.97	1.01
East South Central	.73	.86	.91
West South Central	.87	1.01	1.11
Mountains	1.51	1.78	1.95
Pacific	1.79	2.23	2.37
United States	<u>\$1.12</u>	<u>\$1.30</u>	<u>\$1.41</u>

Source: Crops and Markets - July 1935, p. 242

Cost of Containers. - There is quite a variation in the cost of containers. Usually the smaller the container the higher the cost per pound of product packed. Fifty-gallon oak barrels can be purchased in bulk for \$2.25 per barrel, f.o.b. factory. Thirty-pound tin containers cost from 20 to 30 dollars per hundred (in bulk) depending upon the type, and whether or not it is lacquered (enamel coated) or plain. Standard number 11 tin cans ($7\frac{1}{2}$ pounds capacity) cost 9 to 11 dollars per hundred in bulk, f.o.b. factory.

Equipment needed in Cold-Packing. - Under commercial operation such equipment as a fruit washer, grades, conveyer tables, scales, and miscellaneous buckets, etc., are needed. However, crude methods of packing require very little and inexpensive equipment. The only equipment essential in packing is a place to grade the fruit, some sort of a water bath for washing, scales, and buckets. The entire packing operations can be done with tubs, buckets, a grading table, scales, and a brix hydrometer where sirup is used in packing.

In cold-packing it is essential that containers be thoroughly clean and sterile before being filled with fruit. Barrels should be coated with wax, or paraffin, and tin containers should be lacquered before they are used.

Cold Storage. - Very little information is available concerning the rates of products held in freezing storage. In Tennessee rates are about 15 cents per 100 pounds when packed in small containers. (See Table XLIX).

These rates on barrels are said to be variable depending upon the quantity of fruit placed in storage, and the length of time it is expected to be stored.

TABLE XLIX

FREEZING STORAGE RATES IN TENNESSEE 1935 (1)

Commodity	Package	Size Lots	Freezer Service Handling		
			Received Frozen	Received Unfrozen	Storage
Fruits	450 lbs.	Bbl.	25¢	75¢	\$1.00
	250 "	"	15	40	.50
	Cartons of 100 lbs. or less	Cwt.	10	20	.15

(1) Source: Rates obtained directly from different cold storage warehouses in Tennessee.

Rates quoted from warehouses in various cities reported in the market survey made by the Tennessee Agricultural Experiment Station can be seen in Table L.

TABLE L

STORAGE RATES IN VARIOUS CITIES, 1935

City	Freezer Service	
	Freezing	Storage
	<u>Bbls. 450#</u>	
Cincinnati, Ohio	Bbls. 50¢	40¢
Cleveland, Ohio	" 60¢	40¢
" "	Cwt. 25¢	12¢
Chicago, Illinois	" 25¢	12¢
Baltimore, Maryland	" 20¢	12¢
" "	Bbls. 55¢	40¢
Philadelphia, Pa.	" 50¢	35¢
" "	30# tins 5¢	3¢
New York, N. Y.	" " 7¢	5¢
" " "	Bbls. 60¢	45¢

Source: Tennessee Agricultural Experiment Station Market Survey - 1935. (Information unpublished).

Not so very much difference can be seen in the storage rates in the different cities, which is probably due to keen competition.

If rates are 50 cents per 450 pound barrel per month--the total cost of storage for six months would be \$3.00 or \$0.0066 per pound of product.

Estimated Cost of Freezing Fruit

Estimates for cold packing, from various sources, are approximately the same under comparable conditions. The operations, as has already been mentioned, are confined to capping, washing, grading, transferring the fruit to containers, the addition of sugar, sealing containers, labeling, transporting to cold storage, freezing, and storage. Only a small amount of information is available regarding the costs of freezing; therefore, the figures given in this report are not to be considered as final or complete in all respects.

Cost of Freezing Experimentally. - First let us look at the cost of cold-packing and storing strawberries and peaches experimentally. It must be understood that it would naturally cost more to freeze fruits experimentally than on a commercial basis. In an experimental pack conducted by the Tennessee Valley Authority in 1934 it cost 13.3 cents per pound to freeze and store strawberries for 9 months, and 11.3 cents per pound to freeze and store peaches for 7 months (1) (Tables LI and LII).

TABLE LI

COST OF FREEZING STRAWBERRIES
EXPERIMENTALLY 1/

	<u>Cost per Crate</u>
Full ripe Klondyke strawberries were used - 2-1 pack	
Fruit - 28 lbs. @ 5.5¢ / lb.	\$1.54
Labor - @ 25¢ / hr.	.40
Sugar - @ 5¢ / lb.-14 lbs. required	.70
Container @ 50¢ - 50 lb. tub	.50
Storage - @ 1/3¢/lb./mo. for 9 months having 57 lbs. total weight pack	2.12
Transportation	.25
Miscellaneous expense (water, light, etc.)	.10
Total Cost	<u>\$5.61</u>
Total weight product 42 pounds @ \$5.61 - per pound	.133

(1) TVA Freezing Project, 1934--Unpublished

TABLE LII

COST OF FREEZING PEACHES
EXPERIMENTALLY

	<u>Cost per bushel</u>
Firm ripe Hiley Belle peaches used - 2 + 1 pack made	
Fruit - 1-1/4 bushel @ \$1 / bu.	\$1.25
Labor - peeling @ 25¢ / hr.-requiring 2 1/2 hr./ 1 person	.65
Sugar 15.75 lbs. @ 5¢ / lb.	.79
Container - 50 lb. tub @ 50¢	.50
Storage @ 1/2¢/lb./mo. for 7 months having 52 lbs. total weight for pack	1.82
Transportation	.25
Miscellaneous expense (water, light, etc.)	.10
Total Cost	\$5.36
Total weight fruit and syrup - 47.25 lbs.	\$5.36
Cost per pound	0.1134

Cost of Commercial Freezing. - Wiegand, of Oregon, in his cost analysis of cold-packing strawberries, estimates the total cost per pound at \$6.63 when packed in one pound paper cartons. (Table LIII). In his analysis, containers, sugar, freezing and storage were the largest items of expense.

According to TVA estimates, it cost 3.78¢ per pound to pack, freeze, and store strawberries for 6 months. This does not include the cost of the fruit. Assuming the fruit can be sold for 6.5 cents per pound f.o.b. storage house, 2.71 cents per pound would be the profit per pound of product. This 2.71 cents per pound is equivalent to \$12 per 450 pound barrel. Now, only 300 pounds out of each 450 pound barrel is fruit. Therefore, farmers would get 4 cents per pound for their strawberries, or \$1.44 per 36 pound crate of fruit (Table LIV).

TABLE LIII

ESTIMATED COST OF FREEZING STRAWBERRIES IN ONE-POUND
FIBER CARTONS

<u>Item</u>	<u>Cost per 24-pound</u>
Lithographed cartons per case 24/1	\$0.68400
Direct labor, handling, sorting, filling, capping, etc.	.15300
Receiving	.00900
Royalty on Grading Equipment	.00450
Light and power	.00600
Water	.00050
Sugar @ 5.00/ cwt. delivered	.30000
Freezing and storage 3 months	.22000
24/1 cases corrugated made up	.09767
Loading in cars	.01000
Overhead	.10800
Total cost 24 lbs.	<u>\$1.5917</u>
Average cost per pound	0.0663

Source: Wiegand, "Frozen-Pack Method of Preserving Berries"
Oregon Agricultural Experiment Station Bulletin 278, p. 19

During the 1935 strawberry season the Tennessee Valley Authority conducted some experiments to determine the possibilities of freezing strawberries on a commercial basis in the Valley Area. Their estimates, following these experiments indicate that it costs about 3.78 cents per pound to pack, freeze, and store the fruit for 6 months. (Table LIV).

TABLE LIV

ESTIMATED COST OF FREEZING STRAWBERRIES ON A COMMERCIAL
BASIS

<u>Item</u>	(TVA Estimates)	
	<u>Per Barrel</u>	<u>Per Lb. Products</u>
Labor (Fruit Received Capped)	\$1.71	\$0.0048
Containers (50 gal. oak barrel)	2.25	.0050
Sugar (150 lbs. @ 5¢)	7.50	.0166
Drayage	.90	.0020
Freezing and first month storage	1.00	.0022
Storage (5 additional months)	2.50	.0055
Overhead	.50	.0011
Brokerage fee - 4% discount @ 6-1/2¢/lb	.30	.00066
Total	<u>\$16.66</u>	<u>\$0.03786</u>

Mr. Craddock, of Humboldt, Tennessee, gave the following figures as rough estimates of what it cost to pack strawberries in barrels for freezing in his cannery (see Table LV).

TABLE LV
ESTIMATED COST OF COLD-PACKING IN WEST TENNESSEE

	<u>Per Barrel</u>	<u>Per Pound</u>
Fruit	\$14.40	.0320
Sugar	7.50	.0166
Capping	3.00	.0066
Barrels	2.25	.0050
Labor	1.00	.0022
Total	<u>\$28.11</u>	<u>0.0624</u>

Source: Mr. Craddock of Humboldt, Tennessee.

In the final analysis of costs one must consider the cost of equipment, the depreciation, and the rent of a building, insurance and other expenses.

A TVAC cannery at Waynesville, North Carolina, was studied as a possible location for freezing blackberries and other small fruits. This cannery had a capacity of about 6,000 standard No. 10 cans per 15 hours, using 50 workers. The value of the building and equipment was estimated at about \$35,000. Managerial labor was assumed at about \$23.66 per day. Heat light, water, etc. cost approximately \$23.20 per day. (See Table LVI).

Using standard canning equipment, as at Waynesville, North Carolina, it will cost about $3\frac{34}{100}\%$ per pound to pack, freeze, and store strawberries for 6 months. (See Table LVI). At this cost farms could make a return of about \$1.43 per crate of berries, if the frozen fruit could be sold for as much as $6\frac{1}{2}$ cents per pound.

TABLE LVI

ESTIMATED COST OF COLD-PACKED FRUIT
AT WAYNESVILLE, NORTH CAROLINA

<u>Item</u>	<u>Per 15-hr. day</u>
Interest on investment \$35,000 @ 6%	\$ 5.75
Depreciation @ 10%	9.60
Water, lights, fuel	23.20
Insurance, taxes, etc.	1.00
Total Indirect Costs	<u>\$39.55</u>
Managerial labor	25.00
Common labor (50 : 25¢/hr.)	187.50
Total Labor Cost	<u>\$212.50</u>
Containers - using barrels @ \$2.25	202.50
Sugar	675.00
Transportation and cold storage	90.00
Freezing @ 75¢/barrel	67.50
Storage 6 months @ 50¢/ mo./bbl.	270.00
Total	<u>\$1305.00</u>
Grand Total	<u>\$1557.05*</u>
Production 40,500 lbs. per 15 hrs.	
Cost per pound	.0384

Source: TVA Freezing Project 1934 (unpublished)

In summing up these costs on freezing strawberries, it seems that the fruit can be packed, frozen, and stored for about 6 months for about 3.75¢ to 3.85¢ per pound of product. In a pack of this kind 300 pounds of fruit and 150 pounds of sugar is used per 50-gallon barrel.

Cost of Freezing Peaches. - No published information was available on the cost analysis of freezing peaches. The only data available was the time required for various operations in packing, the cost of sugar, the cost of containers, and the cost of freezing and storage which had been estimated by the TVA (unpublished); from these data a cost analysis was made. According to these estimates, it cost 7.18¢ per pound to pack, freeze, and store the peaches for 6 months, assuming the fruit to cost \$1.00 per bushel (Table LVII).

TABLE LVII

ESTIMATED COST OF FREEZING PEACHES

<u>Item</u>	<u>Cost</u>
Peaches - 1 bu. (50 lbs.)	\$1.000
Sugar - 10 pounds	.500
Containers - (gal. tin)	.700
Labor - @ 25¢/hr.	.650
Transportation	.100
Freezing	.100
Storage (45 lbs. for 6 mo.)	.075
Overhead	.100
Total cost	<u>\$3.225</u>
Cost per pound	.0716

(1) Source: Estimated from experimental data collected by TVA, 1935
(unpublished)

SUMMARYSummary

In determining the exact cost of freezing every job must be broken down and analyzed. Capping is the first major operation that must be done before the fruit is frozen. In the Pacific Northwest strawberries are usually capped on the farm before they are brought to the packing plant. This enables the growers to get about 25 cents more per crate for his fruit than is possible with uncapped fruit. Growers do not have to furnish crates when the fruit is to be frozen, which is a saving of another 25 cents per crate.

When berries are capped on the farm deterioration is very rapid, and the fruit should not be left in this condition any longer than is absolutely necessary.

According to the opinion of fruit growers strawberries can be capped on the farm for about 1 cent per quart (24 cents per crate).

Equipment needed in cold packing should consist of facilities for washing, grading, and weighing the fruit, and sealing the containers.

According to prevailing labor wages in the South, strawberries can be packed, frozen and stored 6 months for about $6\frac{1}{2}$ cents per pound, with fruit at \$1.40-\$1.50 per 24 quart crate. By freezing the fruit, farms save the cost of crates which is about 25 cents each, and can market more of this crop.

The cost of packing, freezing, and storage for 6 months ran from 5.05 cents per pound to 3.87 cents per pound.

The largest items of cost in this process are sugar, containers, storage, and labor.

CHAPTER V

THE MARKETING OF FROZEN FRUITIntroduction

Very little information has been published on the phases of marketing frozen fruit such as methods, agencies, and markets. Publications on the subject deal primarily with packaging, handling, and transporting the product to the consumers, retailers, or wholesalers. This chapter deals with such phases of marketing as methods and agencies engaged in distributing the product, marketing costs, the consuming markets, the types of containers used in marketing, the varieties of fruit commonly packed, the common packs found on the market, users of frozen fruit, and the prices paid on various markets.

This information is based primarily on a market survey made by the Tennessee Agricultural Experiment Station in 1935, and various issues of the Western Canner and Packer. Too, much of this information was obtained from well informed persons by means of letters, questionnaires, and personal contacts.

Marketing Agencies

At the present time nearly all cold-pack fruits which enter the channels of trade are sold by brokers and jobbers at the central market. In only a few instances have frozen-food concerns made sales through their salesmen. It is probably too expensive for individual packers to hire salesmen on a salary basis, since the business of the average packer is not large enough to warrant such a policy. However, some highly specialized concerns, like General Foods Corporation, of New York City, find it economical to sell frozen food through their own

sales organization.

In several instances, processors, such as preserve and jam manufacturers, pack their own fruit instead of buying it. There may be several advantages to this method of obtaining a fruit supply, depending upon conditions under which a given concern operates. In the first place, the preserver might be more certain of getting fruit that has been properly packed and frozen; second, he saves the broker's fee and whatever profit would have been made at a private packing plant; third, he has less risk of an increased cost due to fluctuation in market price of frozen fruit. Probably the principal disadvantage of this method is the excessive cost of labor and equipment needed in the packing of fruit unless a very large quantity is packed.

Often processors make contracts directly with concerns (cold-packers) to freeze a certain quantity of fruit for them. Such an arrangement is economical to the processor to the extent of eliminating the various middlemen. However, if the price of frozen fruit should happen to go down during the winter, such processors might meet strong competition from those who purchase their supply of frozen fruit at current market prices.

Sometimes frozen fruit is sold by jobbers and brokers to wholesalers, who in turn sell the fruit to retailers, or direct to hotels, restaurants, bakeries, clubs, and ships. In only a few instances has the handling of frozen fruit been through retailers. However, the retailing of frozen foods has grown very rapidly during the past three or four years which is noticed in the increased number of

in
small containers being packed. The principal obstacle/retailing of frozen food is the lack of adequate refrigerated facilities by the retailers for handling this commodity. "General Foods", and several other concerns, however, have started retailing these frozen foods in several of the large Eastern cities and have been rather successful. During the early part of 1936 this company opened an office at Knoxville, Tennessee, to supply frozen food to the restaurants, hotels, clubs, and individuals of this city.

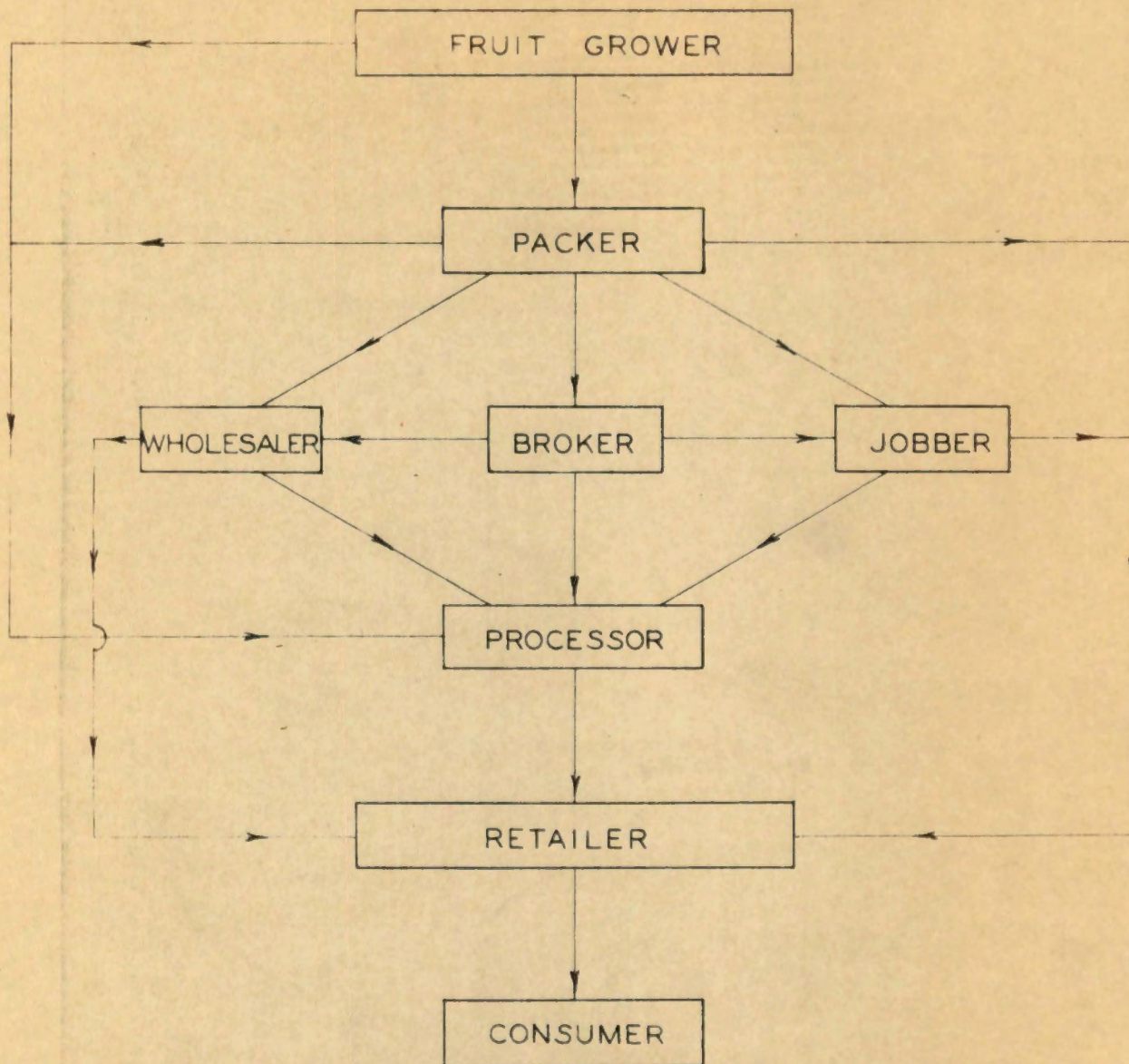
The channels of marketing frozen fruit are shown in figure 33.

Some Costs of Marketing Frozen Food

The items of cost in the marketing of frozen fruit vary with the methods of marketing. Generally, the costs are confined to handling, storage, freight, (including refrigeration during transit), and broker's fee. Where processors, such as ice cream manufacturers, etc., pack their own fruit there is, of course, no broker's fee. If the frozen product is sold through retail stores there are advertising and distribution expenses unknown to other methods of marketing.

According to the Market Survey made by the University of Tennessee, the broker's fee is usually 4 percent of the selling price of the product.

The freight rate in refrigerated cars is \$1.05 for 100 pounds from Seattle, Washington to Chicago and other Midwestern and Eastern cities (Table LVIII).



SOURCE: Market Survey, Tenn. Agr. Exp. Sta. 1935 (unpublished)

FIG.33- CHANNELS OF MARKETING FROZEN FRUIT

TABLE LVIII

STANDARD REFRIGERATED FREIGHT CHARGES ON COLD-PACK BERRIES, 1935

Destination Points	Seattle, Washington		Chattanooga, Tenn.		Nashville, Tenn.		Memphis, Tenn.	
	Rate per 100 lbs. (cents)	Per Car	Rate per 100 lbs. (cents)	Per Car	Rate per 100 lbs. (cents)	Per Car	Rate per 100 lbs. (cents)	Per Car
Chicago	105	\$81.00	94	\$65.00	76	\$62.50	82	\$62.50
Cleveland	105	90.00	93	65.00	84	70.00	97	70.00
Detroit	105	90.00	95	70.00	86	75.00	95	75.00
Boston	105	99.00	117	85.00	126	85.00	134	85.00
New York	105	90.00	108	77.50	117	77.50	126	77.50
Philadelphia	105	90.00	103	77.50	112	77.50	122	77.50
Baltimore	105	94.50	99	77.50	108	77.50	117	77.50
Terre Haute	105	85.50	82	65.00	64	67.50	72	62.50

Source: Information supplied by Mr. Harry Carlton, Market Investigator, University of Tennessee.

Another cost that might be considered a marketing cost is the storage of the product after it has been frozen. Cold storage costs about 15 cents per 100 pounds per month in small containers and 50 to 75 cents per month when in barrels. Tennessee has only a very slight advantage over the northwest in standard refrigerated freight charges. In fact, the Northwest has a slightly more favorable rate to such cities as Boston and New York, and in some cases to Philadelphia and Baltimore (Table LVIII). However, competition of refrigerated trucks might result in these rates being lowered from Tennessee shipping points. At present the volume of cold-pack fruits is insufficient for the development of such competition.

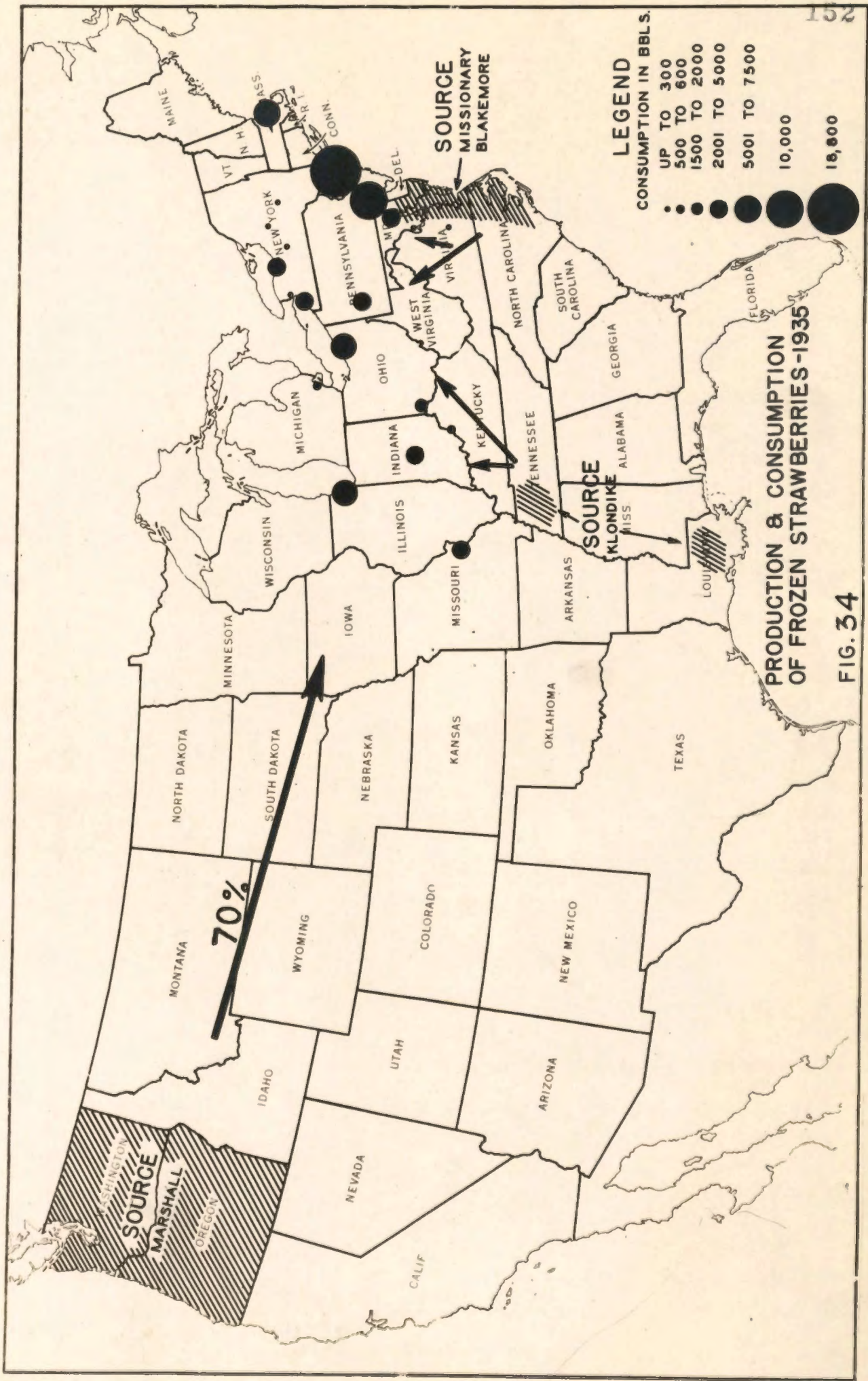
Major Consuming Markets

Cities Using Frozen Fruits. - Frozen fruit is used primarily by preserve and ice cream manufacturers, and by bakers. It is used to a less extent by restaurants, hotels, clubs, ships, soda fountains, and individuals.

As a general rule, the largest markets for frozen fruit are in the large cities. New York is by far the largest city in the consumption of frozen strawberries. Philadelphia comes second, with Chicago, a good third in the use of this particular commodity.

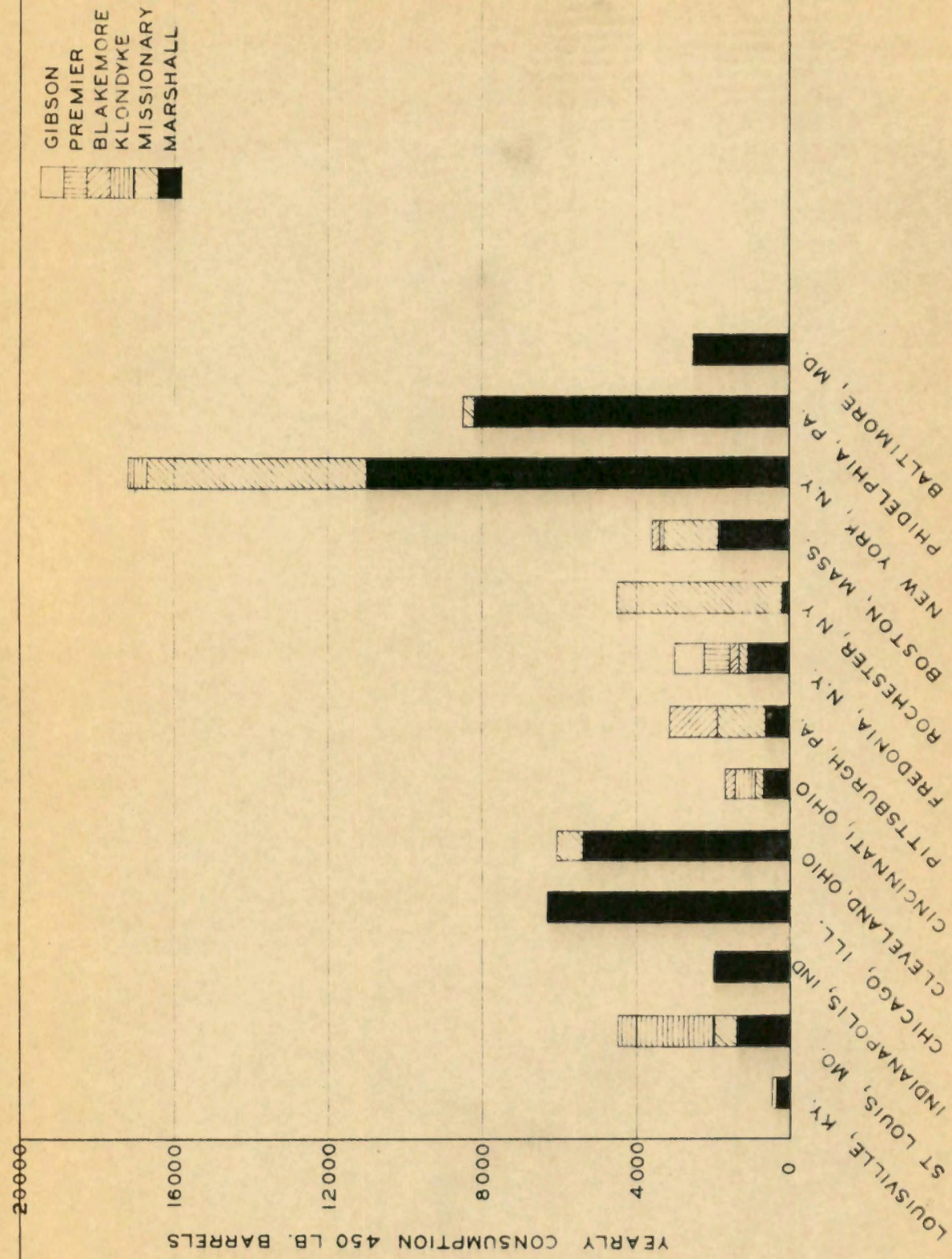
According to the Western Canner and Packer,⁽¹⁾ the largest markets for western cold-pack fruits are: Seattle, Salem, Los Angeles, St. Louis, Minneapolis, Louisville, Cincinnati, Philadelphia, New York, Portland, San Francisco, Denver, Kansas City, St. Paul, Milwaukee, Cleveland, Pittsburgh, Boston, and Chicago.

(1) Western Canner and Packer - Statistical No., March 1935, p. 183.



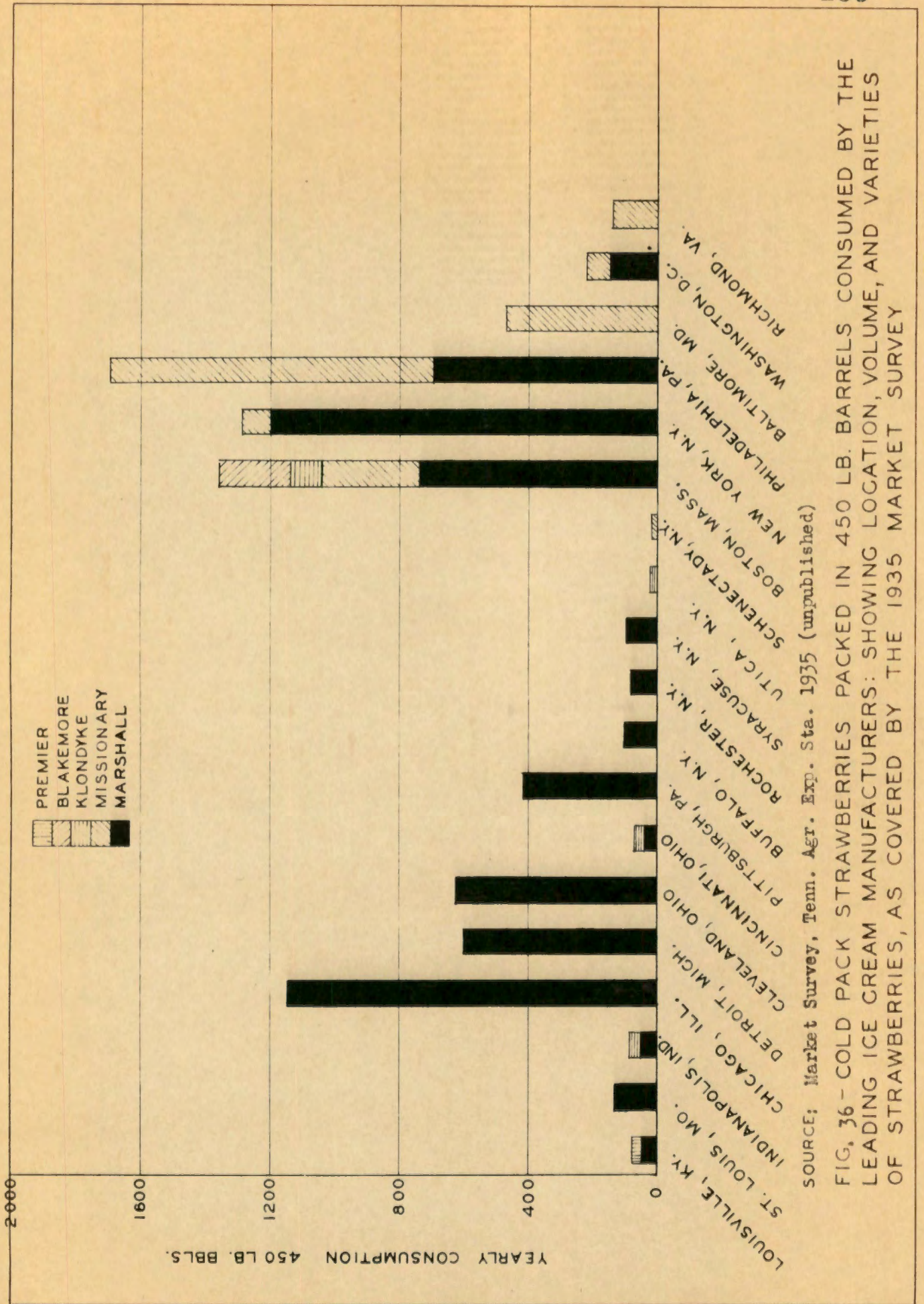
Varieties of Frozen Strawberries Consumed by Cities. - The varieties of strawberries frozen, in order of their importance, are Marshall, Missionary, Klondyke, Blakemore, Premier, and Gibson (figures 35 and 36). At the present time the Marshall strawberry is an unofficial standard for cold-pack strawberries. It has been selected for this standard because it is probably the easiest variety of strawberries to freeze, and at the same time the berry has good culinary qualities.

Practically all of the cold packed Marshall strawberries come from Oregon and Washington. The frozen Klondyke come mostly from Louisiana and Tennessee, and the Missionary from Virginia, Maryland, and some from North Carolina. The frozen Blakemore, berries come from North Carolina, Virginia, and Maryland (figures 37, 38, 39 and 40).



SOURCE: Market Survey, Tenn. Agr. Exp. Sta. 1935 (unpublished)

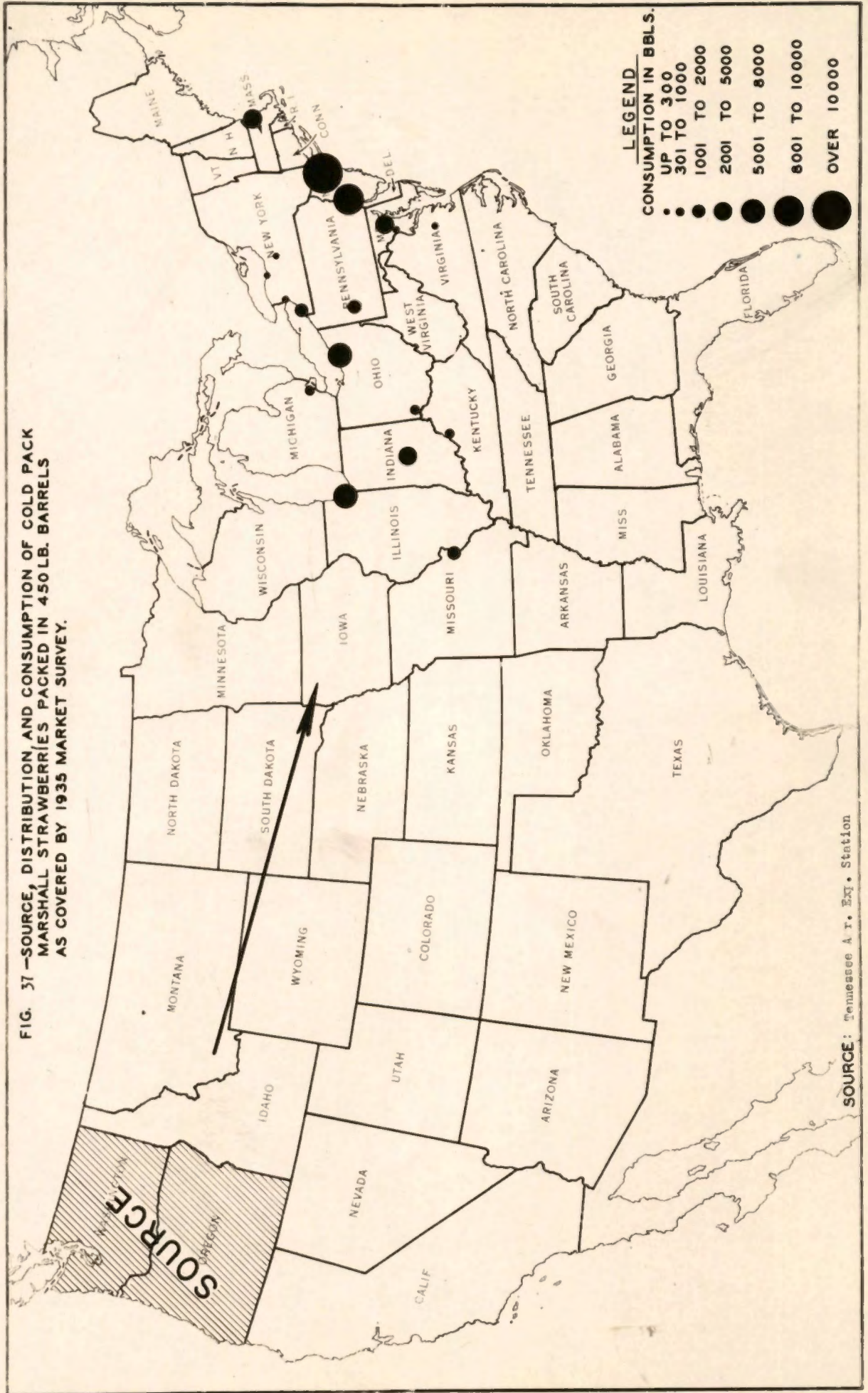
FIG. 35 - COLD PACK STRAWBERRIES PACKED IN 450 LB. BARRELS CONSUMED BY PRESERVE MANUFACTURERS: SHOWING LOCATION, VOLUME, AND VARIETIES OF STRAWBERRIES, AS COVERED BY THE 1935 MARKET SURVEY



SOURCE: Market Survey, Tenn. Agr. Exp. Sta. 1935 (unpublished)

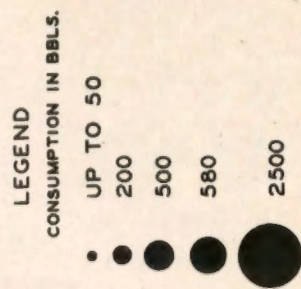
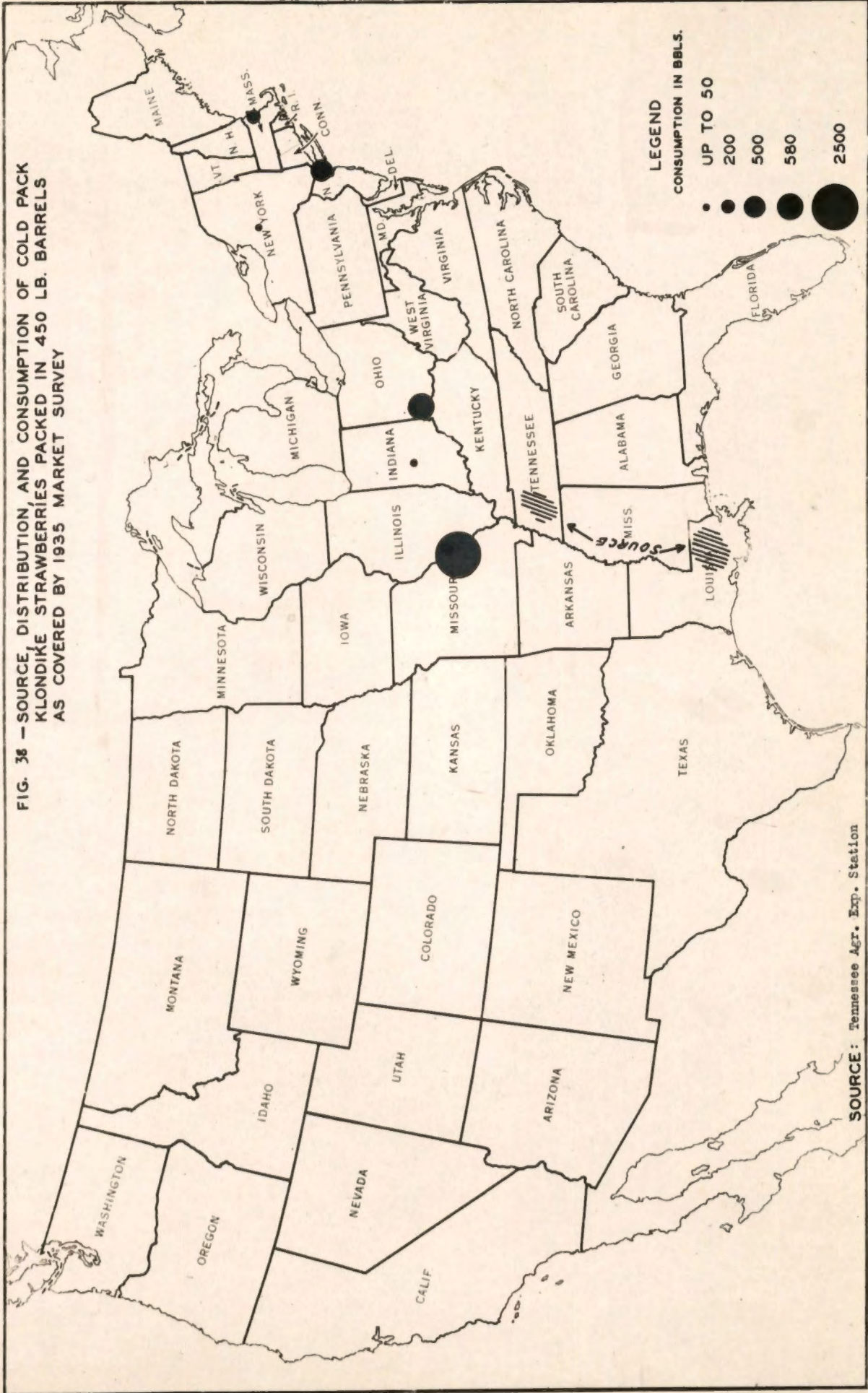
FIG. 36 - COLD PACK STRAWBERRIES PACKED IN 450 LB. BARRELS CONSUMED BY THE LEADING ICE CREAM MANUFACTURERS: SHOWING LOCATION, VOLUME, AND VARIETIES OF STRAWBERRIES, AS COVERED BY THE 1935 MARKET SURVEY

FIG. 37—SOURCE, DISTRIBUTION, AND CONSUMPTION OF COLD PACK MARSHALL STRAWBERRIES PACKED IN 450 LB. BARRELS AS COVERED BY 1935 MARKET SURVEY.



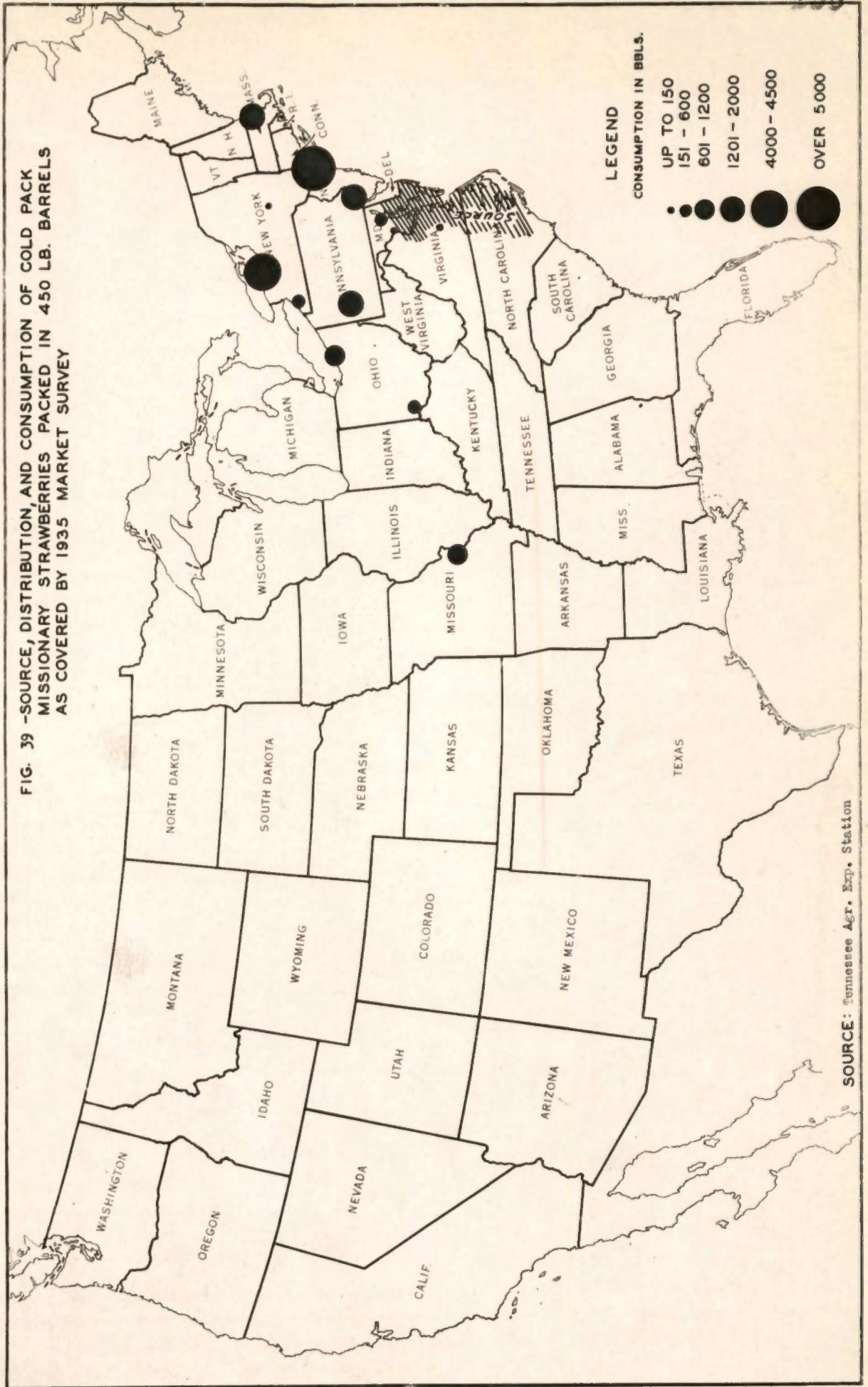
SOURCE: Tennessee A. R. Exp. Station

FIG. 36 - SOURCE, DISTRIBUTION, AND CONSUMPTION OF COLD PACK KLONDIKE STRAWBERRIES PACKED IN 450 LB. BARRELS AS COVERED BY 1935 MARKET SURVEY



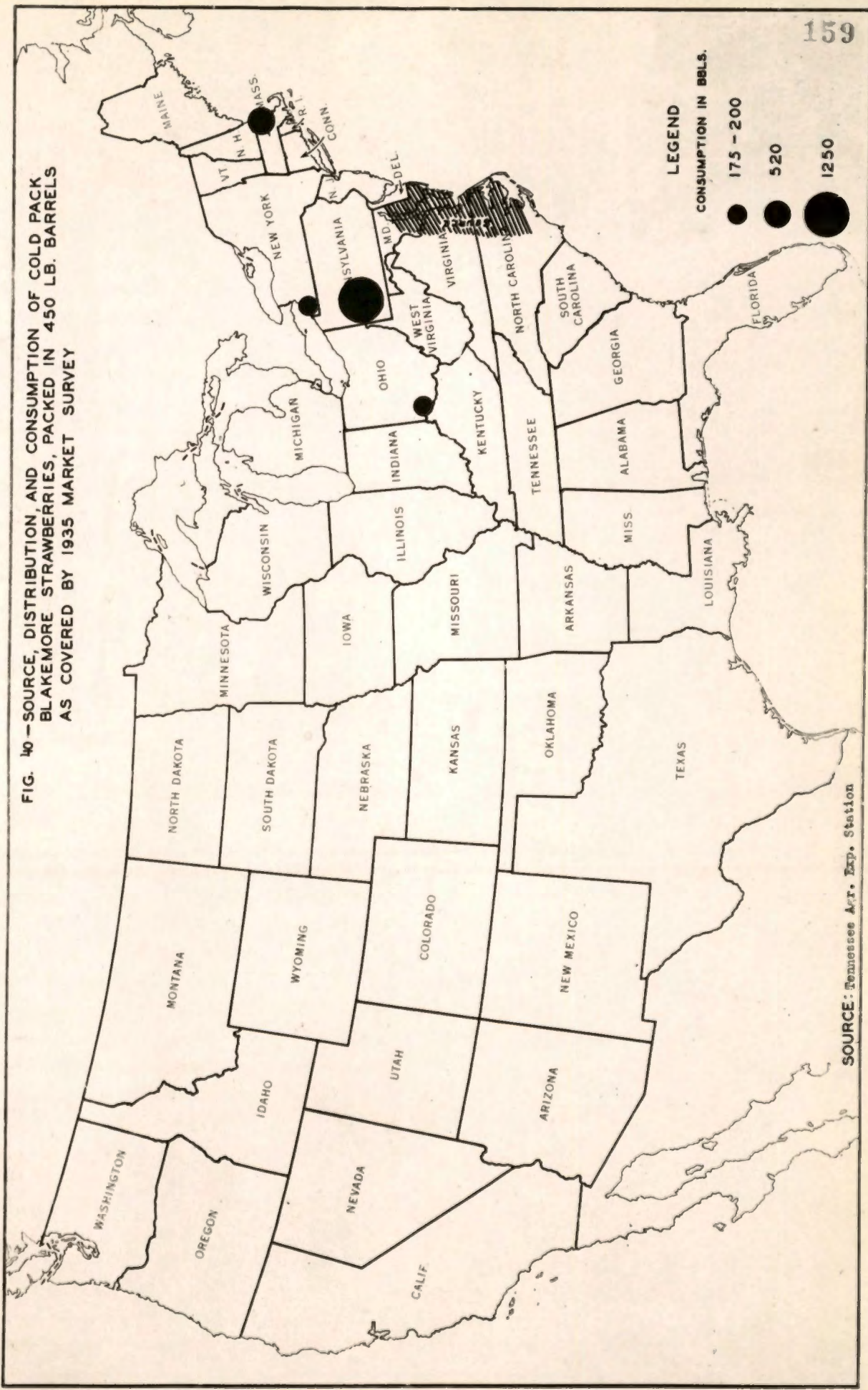
SOURCE: Tennessee Agr. Exp. Station

FIG. 39 -SOURCE, DISTRIBUTION, AND CONSUMPTION OF COLD PACK MISSIONARY STRAWBERRIES PACKED IN 450 LB. BARRELS AS COVERED BY 1935 MARKET SURVEY



SOURCE: Tennessee Agr. Exp. Station

FIG. 40 - SOURCE, DISTRIBUTION AND CONSUMPTION OF COLD PACK BLAKEMORE STRAWBERRIES, PACKED IN 450 LB. BARRELS AS COVERED BY 1935 MARKET SURVEY



Markets for other Frozen Fruit. - On the preceding pages the source and distribution of strawberries has been shown. Although, the largest quantity of fruit frozen is strawberries, other fruits are of considerable importance. Raspberries, blackberries, blueberries, and other fruits are very important products in the frozen food business. Most of the raspberries are consumed in New York City, Cleveland, Chicago, and Boston (figure 41). Most of the blackberries are consumed in New York, Pittsburgh, and Cincinnati (figure 42), and Philadelphia.

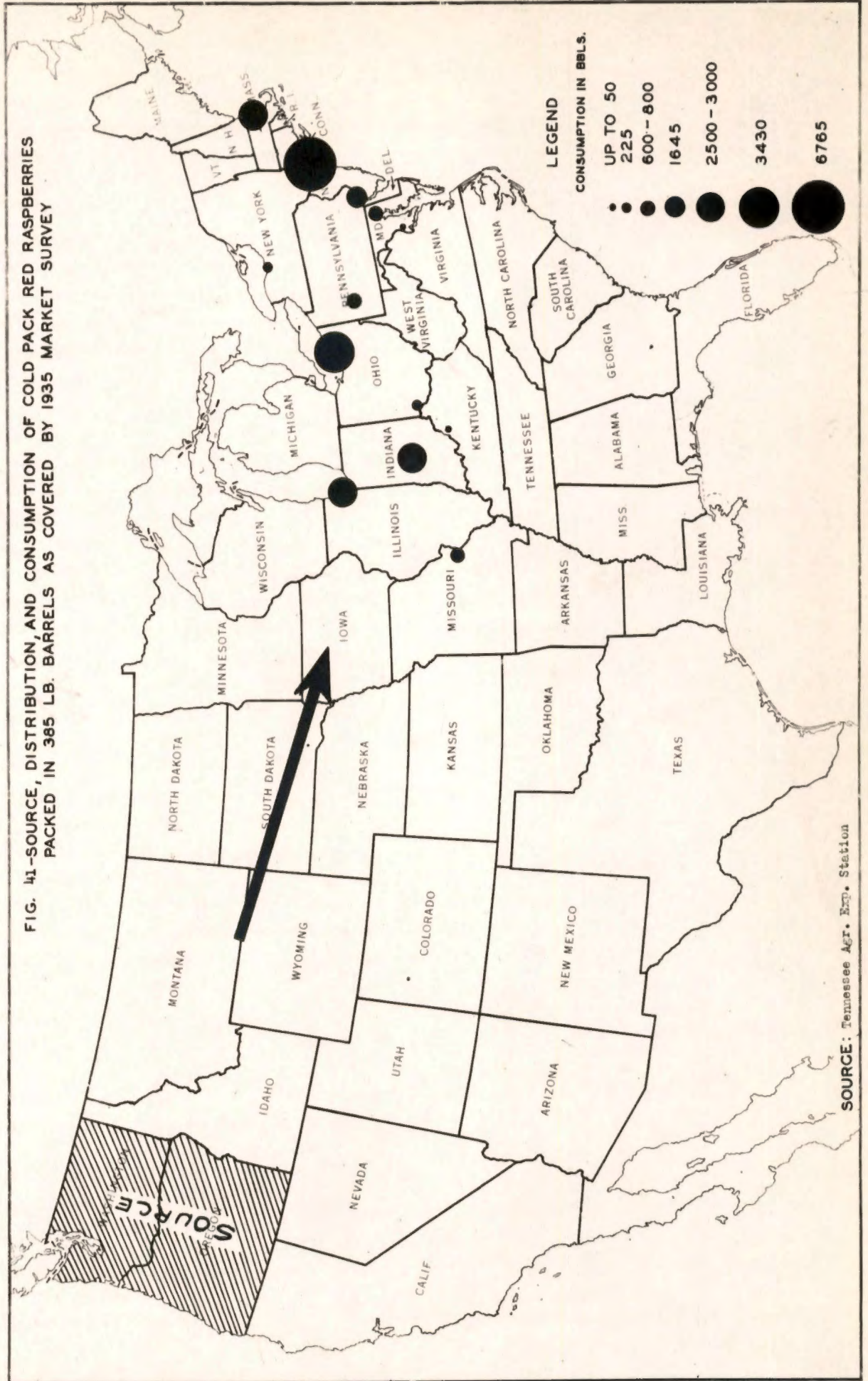
Nearly all of the cold-packed blueberries are consumed in New York, Boston, Detroit, and Chicago. An interesting point in this connection is that practically all of the frozen blueberries consumed in this country are imported (see figure 43).

Number Commercial Consumers by Cities. - The concerns using frozen fruit, as shown by the market survey are comparatively few in number. Chicago reporting more concerns than any other city, had only 17 concerns reporting. The total number of concerns in the Eastern part of the United States, reported as using frozen fruit, is 141 compared to 180 concerns that are using or handling the product in 1935 (Table LIX).

Types of Containers Used

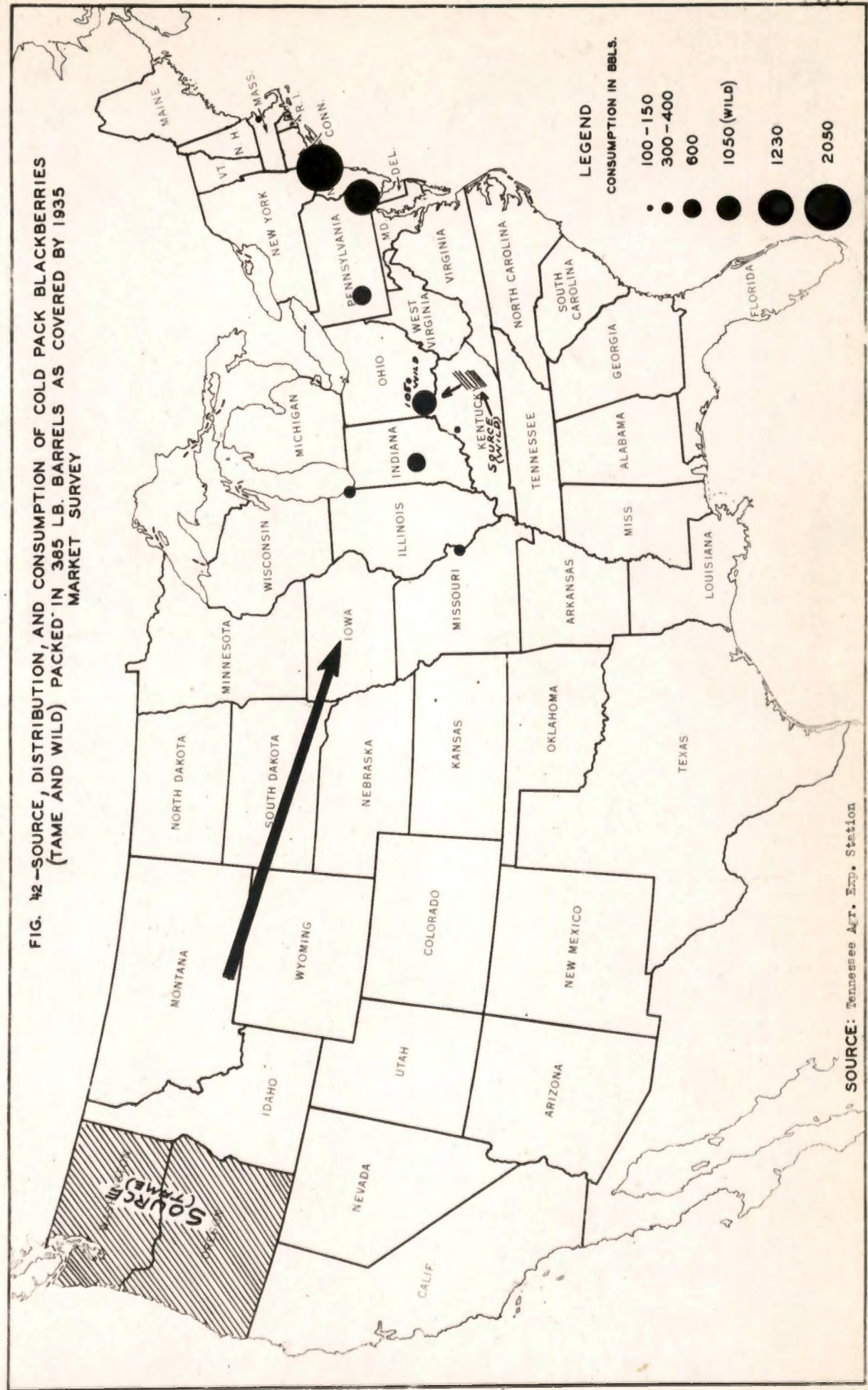
In most foods heat transfer during freezing and thawing takes place chiefly by conduction rather than by convection. Thus, the shape of the container, the thickness of the container walls, and the conductivity of these walls are important in the rate of temperature changes. Other factors being equal, the container having the greater surface exposed per unit volume is the more desirable, so far as the rate of cooling is concerned. For containers of the same material and shape, heat transfer is slower in

FIG. 41—SOURCE, DISTRIBUTION, AND CONSUMPTION OF COLD PACK RED RASPBERRIES
PACKED IN 385 LB. BARRELS AS COVERED BY 1935 MARKET SURVEY



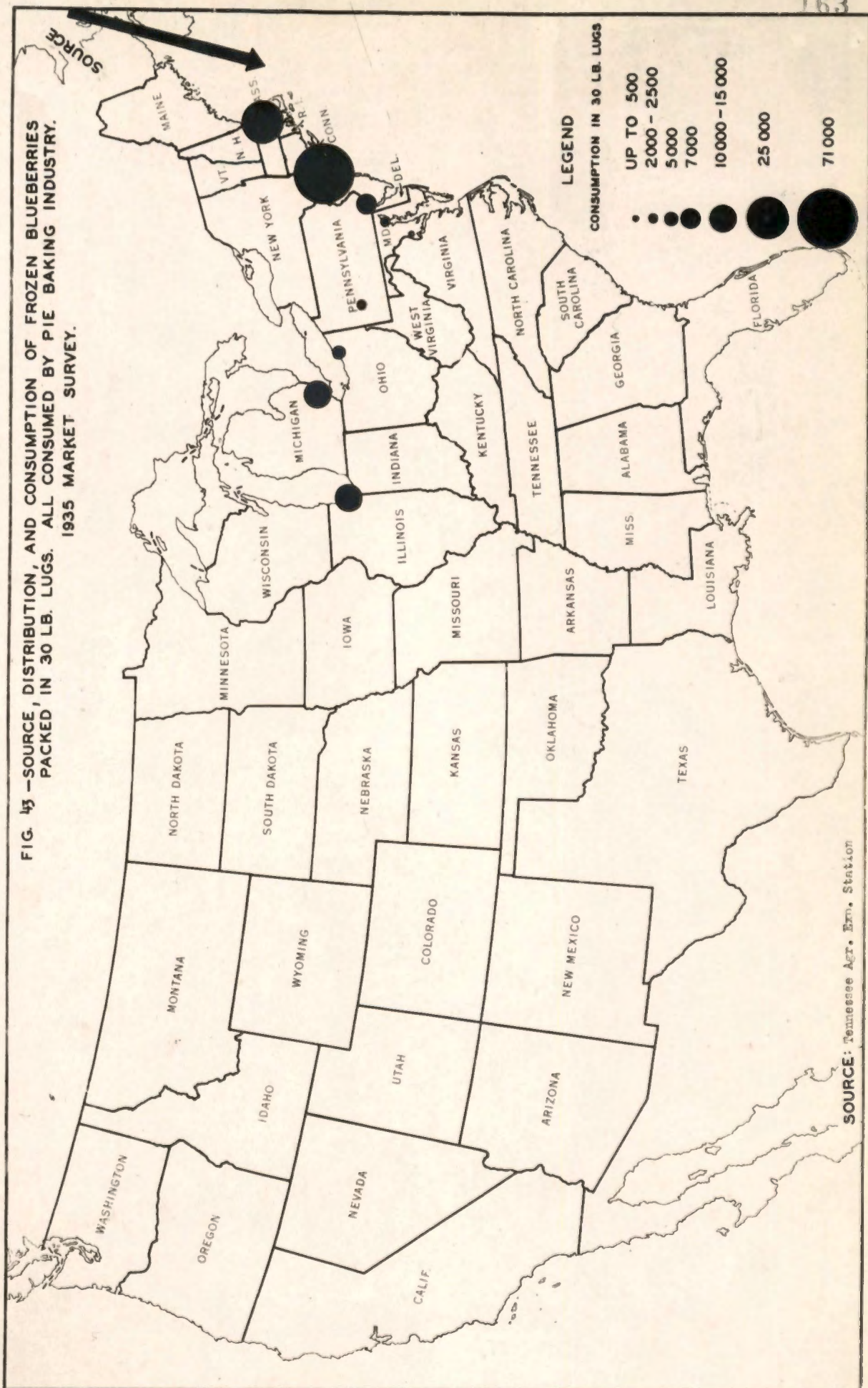
SOURCE: Tennessee Agr. Exp. Station

FIG. 42--SOURCE, DISTRIBUTION, AND CONSUMPTION OF COLD PACK BLACKBERRIES (TAME AND WILD) PACKED IN 385 LB. BARRELS AS COVERED BY 1935 MARKET SURVEY



SOURCE: Tennessee Agr. Exp. Station

FIG. 45 -SOURCE, DISTRIBUTION, AND CONSUMPTION OF FROZEN BLUEBERRIES PACKED, IN 30 LB. LUGS. ALL CONSUMED BY PIE BAKING INDUSTRY. 1935 MARKET SURVEY.



SOURCE: Tennessee Agr. Exp. Station

TABLE LIX
 NUMBER OF CONCERNS IN SPECIFIED CITIES
 USING OR HANDLING FROZEN FRUIT -- 1935

	<u>Concerns Using Frozen Fruit</u>	<u>Total Concerns Handling and Using</u>
Cincinnati, Ohio	9	11
Cleveland, Ohio	7	11
Orville, Ohio	1	1
Wooster, Ohio	1	1
Detroit, Michigan	7	9
Chicago, Illinois	17	21
Indianapolis, Indiana	5	6
St. Louis, Missouri	5	9
Louisville, Kentucky	3	3
Nashville, Tennessee	2	4
Knoxville, Tennessee	2	3
Pittsburgh, Pennsylvania	8	14
Philadelphia, Pennsylvania	8	11
Boston, Massachusetts	6	13
Cambridge, Massachusetts	3	3
Malden, Massachusetts	1	1
Everett, Massachusetts	1	1
Somerville, Massachusetts	2	2
Newark, New Jersey	1	1
New York, New York	13	28
Bronx, New York	1	1
Long Island, New York	2	2
Buffalo, New York	3	4
Brooklyn, New York	9	9
Fredonia, New York	1	1
Schenectady, New York	1	1
Sodus, New York	1	1
Rochester, New York	4	6
Brockport, New York	1	1
Baltimore, Maryland	12	17
Crisfield, Maryland	1	1
Shelbyville, Delaware	1	1
Norfolk, Virginia	1	1
Norfolk & Wilmington, North Carolina	<u>1</u>	<u>1</u>
Total	141	180

Source: Market Investigation conducted by the University of Tennessee,
 1935. (Unpublished)
 Includes Brokers, Jobbers, Wholesalers, Cold Storage Houses, etc.

larger than in smaller containers. In the freezing of fruit in barrels the temperature of the product in the center of the barrel may remain above 40°F. for over 36 hours unless subjected to very low temperatures. Sometimes losses from fermentation occur as a result of this high temperature in the center of the barrel. ^{2/}

Comparative Advantage of Certain Types

As a general rule, the larger users of frozen fruit prefer barrels. The small users prefer 30, 15, and 10 pound tin containers. Barrels are not only very convenient to handle and store but do not require much space in storage. However, they do not allow very fast heat transfer and, therefore, are objectional for freezing unless temperatures of 0°F. to minus 10°F. are used.

Tin containers have several advantages in freezing: first, they allow very rapid heat transfer; second, they are light and easy to handle; third, they are relatively inexpensive.

Glass containers for individual consumption have the advantage of leaving the product visible to the consumer. However, glass is relatively expensive, heavy in weight, hard to label, and easily broken when subjected to severe shocks or sudden changes in temperature.

For individual consumption paper cartons and paper cups, ranging in capacity from 1/4 pound to 2½ pounds are generally used. These paper containers have the advantage of being inexpensive, very light in weight, and easy to label and handle.

^{2/} Joslyn, M. A. "Preservation of Fruits and Vegetables by Freezing Storage". Calif. Agr. Exp. Sta. 320, 1930, p. 6.

TABLE LXI
 NET WEIGHTS OF BARRELS, CANS, AND PAPER CUPS OF FROZEN FRUIT
 (POUNDS PER CONTAINER)

Item	50 Gal. B.	30# Tin	5 Gal.	2 Gal.	10#	1 Gal.	Cups
Strawberries							
5 x 1	---						
4 x 1	400						
3 x 1	420	30	40	16	10	8	1
2 x 1	450						
Straight	380						
Raspberries - and B.							
5 x 1	---						
4 x 1	400						
3 x 1	420	30	40	16	10	8	1
2 x 1	450						
Straight	380	30 for R-28 B	38	B 15	B 9	B 7½	15 oz.
Blackberries							
5 x 1	---						
4 x 1	400						
3 x 1	430	30	40	16	10	8	1
Straight	390						
Loganberries							
5 x 1	---						
4 x 1	400						
3 x 1	420	30	--	16	10	8	1
2 x 1	450	0	--				
Straight	380	28	--	15	9	7½	--

TABLE LXI (CONTINUED)
 NET WEIGHTS OF BARRELS, CANS, AND PAPER CUPS OF FROZEN FRUIT
 (POUNDS PER CONTAINER)

Item	50 Gal. B.	30 $\frac{1}{2}$ Tin	5 Gal.	2 Gal.	10 $\frac{1}{2}$	1 Gal.	Cups
Cherries							
5 x 1	420					8	1
4 x 1	450		40	16	10		
3 x 1	450	30					
Huckleberries							
5 x 1	---	30	--	15	10	7 $\frac{1}{2}$	--
Straight	325	27	--	15	8	7	--
Peaches							
2 x 1	450	---	40	16	--	8	--

Source: Western Camer and Packer -- Stat. No., Mar. 1935 -- p. 181-2.

The Trend in Size of Containers. - The trend in size of container has been toward the smaller size in the case of some fruits. For instance, in the northwest, the number of barrels of blackberries decreased from 1926 to 1933 while the number of 30-pound tins increased. A similar situation occurred with loganberries. Most fruits packed, however, have not varied much in the type of container since 1926. The number of small containers used in packing strawberries increased markedly until 1929 and 1930, but declined after 1930 (see Table LXII).

Probably most of the fruit packed in small containers (1 to 5 pound) is frozen east of the Mississippi River. This is particularly true for cities that have begun to retail the frozen product.

Prices Received for Frozen Fruit

Wholesale Prices by kinds of Fruit. - Ordinarily the prices received for frozen strawberries have not been less than $6\frac{1}{2}$ cents per pound. From 1927 through 1931 the prices received in the Northwest, ranged from 8 to $10\frac{1}{2}$ cents per pound for berries packed with 2 parts fruit and 1 part sugar. Cultivated blackberries ranged from 5 to 7 cents per pound, and red raspberries from 7 to $11\frac{1}{2}$ cents per pound (Table LXIV).

Prices received for frozen fruit dropped considerably during 1932 and remained fairly low until 1935. During this time strawberries dropped as low as $4\frac{1}{2}$ cents per pound. Blackberries went down to $3\frac{1}{2}$ cents per pound; most other fruits saw similar drops in price during that period (Table LXV).

TABLE LXII

PACIFIC NORTHWEST FROZEN PACK

1926-33, BY KIND OF FRUIT AND SIZE OF CONTAINERS

I NUMBER OF 50 GAL. BARRELS

	Red Rasp.	Logan Berry	B. Rasp.	Black- berry	R S P Cher- ries	Goose- berries	Cur- rants	Prunes
1926	35902	4552	584	8308	---	---	297	---
1927	10699	2175	---	1788	626	50	250	---
1928	38145	2092	1197	7250	275	108	315	---
1929	17017	3144	1107	6484	---	102	585	---
1930	30111	264	1468	6142	956	27	775	115
1931	25385	1751	1646	4169	889	10	725	159
1932	9881	862	948	4092	678	15	813	---
1933	22326	1068	2026	3846	643	---	1021	60

II NUMBER OF 30 GAL. BARRELS

1926	85	61	---	41	3	---	---	---
1927	126	78	---	---	---	---	---	---
1928	78	23	---	590	---	10	---	---
1929	56	124	29	25	1	---	14	---
1930	523	---	150	6	111	---	---	---
1931	41	8	---	6	140	---	---	---
1932	21	19	---	52	267	---	44	190
1933	35	---	---	---	72	---	---	---

III NUMBER OF 30 POUND TIN CANS

1926	---	---	---	---	---	---	---	---
1927	10903	210	10154	3508	---	---	---	100
1928	10937	8641	7626	---	3754	---	---	---
1929	6922	4042	1883	---	4042	---	50	2928
1930	20359	5613	13954	8517	22499	1395	144	5193
1931	21095	13658	3565	8984	9185	687	20	688
1932	7231	6516	1136	9061	22575	600	44	470
1933	10450	12056	3497	10227	14171	1117	23	575

SOURCE: Western Canner and Packer, Stat. No--Mar. 1935, p. 181

TABLE LXII (CONTINUED)

PACIFIC NORTHWEST FROZEN PACK

1926-33, BY KIND OF FRUIT AND SIZE OF CONTAINERS

IV NUMBER OF 15 LB. TIN CANS

	Red Rasp.	Logan Berry	B. Rasp.	Black- berry	Cur- rant	Goose- berry	R S P Cherry	Prunes
1926	---	---	---	---	---	---	---	---
1927	---	---	---	---	---	---	---	---
1928	220	75	200	200	25	25	300	700
1929	628	432	45	508	---	---	1646	12
1930	1854	274	98	437	---	---	1825	100
1931	1078	580	204	402	---	---	324	1174
1932	1571	324	200	784	---	---	148	550
1933	1174	100	100	100	---	---	1730	190

V NUMBER OF 10 POUND CANS

1928	8350	846	---	216	---	2806	385	---
1929	780	2	206	---	---	---	72	---
1930	3094	18	112	358	---	358	12315	396
1931	646	54	---	---	---	---	30	---
1932	616	---	---	52	---	52	---	100
1933	1100	---	---	26	---	---	466	---

VI NUMBER OF NO. 10 CANS

1931	1326	504	650	509	---	480	---	---
1932	---	---	---	150	---	---	---	---
1933	36	---	---	---	---	---	---	---

VII NUMBER OF 5 GAL. CANS

1926	884	809	328	1438	---	---	---	---
1927	4378	818	2196	2332	---	320	87	630
1928	2384	1574	540	2358	48	90	3420	2122
1929	1297	1993	10	1081	---	20	1813	816
1930	1252	2366	---	2639	---	4	2580	692
1931	1390	1492	25	1508	---	---	706	800
1932	800	650	---	113	---	---	1019	500
1933	719	---	---	---	---	---	539	---

TABLE LXII (CONTINUED)

 PACIFIC NORTHWEST FROZEN PACK
 1926-33, BY KIND OF FRUIT AND SIZE OF CONTAINERS

VIII NUMBER OF 2 GAL. CANS

	Red Rasp.	Logan Berry	B. Rasp.	Black- berry	Goose- berry	R S P Cherries	Rhu- barb	Prunes
1929	125	---	---	75	50		100	91
1930	700	---	200	352	323	88	352	352
1931	724	500	---	552	1000	---	400	700
1932	702	200	---	---	---	100	---	300
1933	1108	---	---	200	---	---	---	---

IX NUMBER OF 1 GAL. CANS

1929	236	51	24	106	33			21
1930	498	300	100	---	498			---
1931	600	500	---	804	1000			344
1932	1000	200	---	---	---	100		300
1933	700	---	---	---	---			---

X NUMBER OF 1 POUND CARTONS

1929	84208	24892	696	---		16376		
1930	182498	696	3804	1320	167	59019	120	
1931	141643	7992	2978	---	120	1836	120	120
1932	51044	22200	1064	1332		72	---	---
1933	32672	192	---	60			120	50

TABLE LXIII
 PACIFIC NORTHWEST FROZEN STRAWBERRY PRODUCTION
 BY SIZE OF CONTAINERS

Size of Container	1927	1928	1929	1930	1931	1932	1933	1934
50 gal. bbl.	53828	73544	53382	40519	66825	65659	39784	46497
30 gal. bbl.	606	686	501	292	1000	2096	428	2387
10 gal. kegs	372	543	600	231	712	361	---	16
5 gal. kegs	3262	573	637	587	429	---	6	---
50 lb. cans	---	97	4918	50	405	1054	3	---
30 lb. cans	25402	242714	80483	36571	64997	68187	26960	57876
15 lb. cans	---	21940	15460	4369	6629	11130	3570	6320
10 lb. cans	---	32644	28639	3246	12246	64012	512	15128
No. 10 cans	---	---	---	7206	16128	10464	23847	23640
5 gal. cans	5244	4017	4475	5240	12339	3136	1265	1482
2 gal. cans	---	---	302	804	2724	1562	852	5
1 gal. cans	---	---	1053	1452	4764	1646	400	1124
1 lb. cartons	---	434015	1114853	1672536	1448073	1500015	575317	494454
4 lb. cans	---	---	553429	13332	20004	---	---	---
1 lb. cans	---	---	---	---	18024	1890	---	---
1 gal. cartons	---	---	---	---	---	---	---	324
2 and 2 1/2 cartons	---	246	---	---	112464	100680	---	35600
12 oz. cups	---	---	---	---	---	4964	---	---
8 oz. cartons	---	---	---	---	---	153060	---	---
Bulk in Boxes, lbs.	---	125400	---	---	---	---	---	---

Source: Western Canner and Packer---Stat. No.---Mar, 1935---p. 182

TABLE LXIV
 AVERAGE OPENING PRICES ON THE NORTHWEST FROZEN
 PACK FRUITS

	50-gal. barrels (2 x 1 pack) ^{1/}				
	1927	1928	1929	1930	1931
Strawberries	.105	.0925	.085	10	.08
Cuthbert red rasp- berries	.095	.115	.105	11	.07
Marlboro red rasp- berries	--	--	--	--	--
Loganberries	.07	.075	.08	9	.07
Cultivated Black- berries	.07	.07	.07	.065	.05
Red currants, unsweetened	--	--	--	--	.06
Red sour cherries	--	--	--	--	.07

Source: Western Canner and Packer, March 1935, p. 179-80.

Prices by type of Consumer and by Markets. - There are some slight variations in the price paid for frozen strawberries by the various consumers, and on the different markets. For instance, ice cream manufacturers seem to pay slightly higher prices for fruit than preserve manufacturers. However, in many cases the price is the same. This variation may be due to the fact that the preserve manufacturer buys larger amounts of frozen fruit than the ice cream manufacturer (see Table LXVI) for prices).

The prices paid in the various cities for frozen strawberries in 1935 ranged anywhere from 7 to 10½ cents per pound delivered. The variation in prices in the different cities may have been due to variations in freight cost. (Table LXVI).

^{1/} In referring to the pack used, 2 x 1 or 3:1, etc. means 2 parts of fruit to 1 part of sugar, or 3 parts fruits to 1 part of sugar, etc. N/S means no sugar was used.

TABLE LXV

OPENING PRICES OF NORTHWEST
FROZEN PACK-FRUITS BY SIZE OF CONTAINERS
AND BY PACK, 1932-1934 ^{1/}

1932	50 Gal. Barrels			50 & 30 lbs.	15 lbs.	10 Lb.
	N/S	3X1	2X1	Tins 3X1	Tin 5X1	Tins 5X1
Strawberries	.045	.045	.045	.055	.065	.065
Cuthbert Raspberries	.05	.055	.055	.065	.075	.075
Marboro Raspberries	.04	--	--	--	--	--
Loganberries	.045	.045	.04 $\frac{1}{2}$	.0525	.0675	.0625
Cultivated Blackberries	.035	.0375	.04	.0475	.05 $\frac{1}{2}$	.0575
Red Currants Unstemmed	.05	--	--	.06	.06	--
Red Sour Cherries	.05	.05	--	.06	.0675	.07
Black Raspberries	.05	.05	.05	.06	.0675	.07
<u>1933</u>						
Strawberries	.085	.0825	.08	.0925	.10	.1025
Cuthbert Raspberries	.08	.0775	.07 $\frac{1}{2}$	.0875	.095	.0975
Marboro Raspberries	.07	--	--	--	--	--
Loganberries	.05	.05	--	.06	--	--
Cultivated Blackberries	.04	.045	--	.0525	.06	.0625
Red Currants Unstemmed	.055	--	--	--	--	--
Red Sour Cherries	.055	.055	--	.06 $\frac{1}{2}$	--	--
Black Raspberries	.07	.065	--	.075	.0825	.085
<u>1934</u>						
Strawberries	.065	.065	.06 $\frac{1}{2}$	.075	.08	--
Cuthbert Raspberries	.07	.065	.06 $\frac{1}{2}$	.075	.08	--
Marboro Raspberries	.065	.06	--	.07	.075	--
Loganberries	.05	.05	--	.0575	.065	--
Cultivated Blackberries	.04	.045	--	.055	.06	--
Red Currants Unstemmed	.06	--	--	--	--	--
Red Sour Cherries	--	.055	--	--	--	--
Black Raspberries	.065	.0625	--	.075	.08	--

^{1/} Western Canner and Packer, March 1935 - Page 179-180.

TABLE LXVI

PRICES PAID BY PROCESSORS FOR FROZEN STRAWBERRIES
IN SPECIFIED CITIES, 1935

City	Manufacturers of			
	Preserves (cents per lb.)	Ice Cream (Cents per lbs.)	Pies (Cents per lb.)	Syrup (Cents per lb.)
Cincinnati	7-8-9*	7-9*	7-1/5-10*	
Cleveland	8½-9 /	10-11*	11*	
Detroit		(8½-13½) 9*	8-3/4-9*	
Chicago	8-8½*	8½-9*	5½**	
Indianapolis	9*			
St. Louis	7-1/3*	9*	7**	
Louisville	8-1/2*			
	7*			
	7*	8-9*		
Nashville		5½**	12½*	
Knoxville	8*	8*		
		7*		
Albany & Schenectady		8½*	12½*	
Pittsburgh	6-3/4 /	9½-10½*	10½*	
	6½ /			
Rochester	9½-10½*	9-10*	7-3/4*	
		7-3/4*	9½-10*	
Buffalo	9½-10½*	8-3/4 /		
Montreal	8½-10*			
Utica, N. Y.		15		
Boston	8½*	8½-10*	7*	
	8*	8*	12*	
	7*			
	8*			
	8*			
	9-10*			
New York	7½*	9-10*	8-9*	
Syracuse		9-12*		

* Price delivered as 8* = cuts./lb. delivered

/ " f.o.b. shipping point

** " per crate

Prices by Type of Container. - As would be expected the price of strawberries in small containers is almost invariably higher than in the larger containers. Generally, the price of frozen strawberries during the 1935 season, in 50-pound barrels was $8\frac{1}{2}$ to 9 cents per pound delivered; in 30-pound tins this price was $9\frac{1}{2}$ to $10\frac{1}{2}$ cents per pound, delivered; in 15 pound tins the price was $10\frac{1}{2}$ cents to $12\frac{1}{2}$ cents, delivered (see Table LXVII).

Retail Prices. - The retail price of frozen food has generally been high. However, small restaurants, hotels, and other establishments can purchase frozen fruit in relatively small quantities at reasonable prices. The retail price suggested by Birdseye Frosted Foods Corporation are exceedingly high compared to the price of John Sexton, wholesaler of Chicago (Tables LXVIII and LXIX).

With a selling price of 20 to 25 cents per pound consumers are not going to eat frozen over canned or otherwise preserved food. John Sexton, wholesaler of Chicago, presented a reasonable price of $13\frac{1}{2}$ cents per pound for strawberries, $10\frac{1}{2}$ cents for cherries, 14 cents for blueberries and $13\frac{1}{2}$ cents for red raspberries (Table LXVIII).

TABLE LXVII

AVERAGE PRICES OF FROZEN STRAWBERRIES
IN VARIOUS MARKETS BY TYPES OF CONTAINERS, 1935

City	50-Gal. Barrels	30-Pound Tins Cents Per Pound	15-Pound Tins
Baltimore, Md.	8.16 +	10.5 *	11 *
Boston Area			
Malden	9 *		
Everett	9 +		
Somerville	9.25 +		
Boston, Mass.	8.7 *	9.5*	11.5 *
Buffalo, N. Y.	10 *		
Bronx, N. Y.	8.5 +		
Long Island, N. Y.	8.0 +		
Brooklyn, N. Y.	8.5 *		
New York, N. Y.	9.5 *	11.5 *	12.5 *
Albany, N. Y.		12.5 *	
Scotia, N. Y.	11 +		
Schenectady, N. Y.	8.5 +		
Utica, N. Y.	15 +		
Syracuse, N. Y.	10.5 +	10.5 *	
Rochester, N. Y.	11.2 +		
Philadelphia, Pa.	9.25 +	10.5 *	
Pittsburgh, Pa.	9.5 +	10.5 *	11.5 *

* = Price Delivered

+ = Price F. O. B. Shipping Point

Source: Market Survey - Tenn. Agr. Exp. Sta. 1935.

Note: When exceedingly high prices were paid small quantities were usually purchased.

TABLE LXVIII

SPOT PRICES OF CERTAIN FROZEN FRUITS F.O.B. KNOXVILLE,
APRIL 1935

Blueberries, 40 lb. cans	\$1.14 lb.
Packed 4 parts fruit, 1 part sugar	
Cherries, 30 lb. cans	.10 $\frac{1}{2}$ lb.
Packed 4 parts fruit, 1 part sugar	
Plums, Pitted, 40 lb. cans	.11 $\frac{1}{2}$ lb.
Packed 5 parts fruit, 1 part sugar	
Youngberries, 30 lb. tins	.14 $\frac{1}{2}$ lb.
Packed 4 parts fruit, 1 part sugar	
Strawberries, 40 lb. cans	.13 $\frac{1}{2}$ lb.
Packed 3 parts fruit, 1 part sugar	
Red Raspberries, 40 lb. cans	.13 $\frac{1}{2}$ lb.
Packed 3 parts fruit, 1 part sugar	

Source: Quotation direct from John Sexton Wholesale Company, Chicago, Ill.

TABLE LXIX

PRICES OF FROZEN FOODS QUOTED BY BIRDSEYE FOODS CORPORATION
SEPTEMBER, 1935

	<u>Pkg.</u> <u>Wt.</u>	<u>Dealer</u> <u>Price</u>	<u>Suggested</u> <u>Selling</u> <u>Price</u>
<u>Fruits and Berries</u>			
Cherries, Red Pitted Sweet	16 oz.	.12	.17
Peaches, Sliced, Sweet	16 oz.	.19	.25
Raspberries, Pint Box	10 oz.	.17	.23
Strawberries, Sliced, Sweet	16 oz.	.19	.25
<u>Vegetables</u>			
Asparagus, 5" Tender Tips	12 oz.	.24	.31
Broccoli, Green Tips Only	11 oz.	.17	.23
Corn off cobs, Golden Bantam	14 oz.	.15	.21
Corn on Cob, " "	6 ears	.35 pkg.	.44
Lima Beans, Baby Green	12 oz.	.19	.25
Mushrooms, Fancy Button	6 oz.	.26	.33
Sold in Units of 6 only			
Peas, shelled	10 oz.	.19	.25
Spinach, Washed	14 oz.	.14	.19
Squash, Cooked	16 oz.	.14	.19

Furnished by Birdseye Frosted Foods Corporation

Summary

At the present time most of the frozen fruit is sold through brokers and jobbers to ice cream companies, preservers, etc. In some cases wholesale growers handle the fruit. Some processors go out into the field and do their own packing while others make contracts with packers for a definite quantity. Very little frozen food is handled through retailers, although the amount being handled by this method is increasing.

The largest items of cost in marketing frozen fruit are freight and the broker's fees. Refrigerated freight rates from the northwest to the eastern cities vary from about \$1.00 to \$1.50 per 100 pounds of product. From East Tennessee, rates range from \$0.75 to about \$1.25 per 100 pounds.

Frozen fruit is used mainly in the manufacture of preserves, jam, ice cream, pies, and fruit extracts and flavors.

The largest consuming markets of frozen fruit are New York City, Chicago, Brooklyn, Rochester, Boston, Detroit, Cleveland, Cincinnati, St. Louis, Pittsburgh, Philadelphia, Los Angeles, San Francisco, Seattle, Portland, and Baltimore.

At the present time about 83% of the frozen fruit consumed in the United States comes from the Pacific Northwest.

Among the fruits frozen in order of importance, we have strawberries, raspberries, blackberries, logan berries, cherries.

The most common container in freezing is the 50 gallon barrel, which is followed by the 30 pound container. There is an increasing demand for

smaller containers, however, such as the 30, 15, and 10 pound tins which are adapted to the smaller users.

Generally, frozen strawberry prices have been above $6\frac{1}{2}$ cents per pound F.O.B. shipping point. Smaller containers usually demand slightly higher prices, due to added expense of packing in the small containers. As a general rule the range in prices between the different cities were not great.

BIBLIOGRAPHY

1. Allred, Hopkins, and Atkins, Some Economic Problems of Tennessee Strawberries, Tennessee Agricultural Experiment Station, Department Agricultural Economics Preliminary Report #2, 1952.
2. Anderson, J. L., Communication, Storage, and Distribution in Tennessee, University of Tennessee, Department Agricultural Economics, 1933.
3. Baker, C. T., "Leveling Seasonal Supply by Freezing Georgia Peaches," Food Industries, Vol. 2, 1930.
4. Barfield, B. F., "Frozen Fruit Makes Its Bow to the Consumer," Reprint from Printers Ink Weekly, April 4, 1929.
5. Berry, J. A., "The Microbiology of the Frozen Pack," The Canning Age, Vol. 13, 1932.
6. Birdseye, C., "Where Quick-Frozen Vegetables Stand Today," Food Industry, Vol. 3, 1931.
7. Birdseye, C., "Quick-Freezing of Perishable Foods", Ice and Refrigeration, Vol. 78, 1930.
8. Buskirk, H. H. and Others, "Stability of Vitamin C in Frozen Orange Juice During Prolonged Storage", Industrial and Engineering Chemistry, Vol. 25, 1933.
9. Carlton, Harry, "Market Survey Investigation of Frozen Fruit," Survey conducted by the University of Tennessee, 1935. (Report is unpublished.)
10. Code Authority, 1935, "List of Warehouses Reporting Refrigerated Space, 1935". Washington, D. C.
11. Cruess, W. V., Overholser, E. L. and Bjarnason, S. A., "Storage of Perishable Fruits at Freezing Temperatures", California Agricultural Experiment Station Bulletin 324, 1920.
12. Delf, Ellen M., "The Influence of Storage on the Anti-Scurvy Value of Fruits and Vegetables," Bio-Chemical Journal, Vol. 19, 1925.
13. Diehl, H. C. and Others, "The Frozen Pack Method of Preserving Berries in the Pacific Northwest", U. S. Department of Agriculture Technical Bulletin 148, 1930.

14. Diehl, H. C., "A Physiological View of Freezing Preservation", Industrial and Engineering Chemistry, Vol. 24, June 1932.
15. Fadden, H. D., "Development of Cold-Pack Fruit and Vegetable Industry in the Pacific Northwest", Better Fruit, Vol. 28, 1934.
16. Fellers, Carl K., "Public Health Aspects of Frozen Foods", Massachusetts Agricultural Experiment Station Contribution No. 136, 1932.
17. Fellers, Carl K., "Vitamin C Content of Strawberries and Strawberry Ice Cream", Massachusetts Agricultural Experiment Station Contribution 69, 1933.
18. Food Industries Magazine. Preserving Food-Stuffs by Quick Freezing and Refrigeration, McGraw Publishing Company, New York, New York, 1931.
19. Joslyn, M. A., "Preservation of Fruits and Vegetables by Freezing Storage", California Agricultural Experiment Station Circular 320, 1930.
20. Kuzents, Simon, Seasonal Variations in Industry and Grade, Published by Lord Baltimore Press, Baltimore, Md., 1933.
21. Nelson, E. N. and Mattern, H. H., "Vitamin C Content of Frozen Orange Juice", Industrial and Engineering Chemistry, Vol. 25, 1933.
22. New York Food Marketing Research Council. "Developments in the Production and Distribution of Frozen Foods", Proceedings of the Sixteenth Regular Meeting, 1930.
23. Overholser, E. L., "History of Fruit Storage and Refrigeration in the United States", Better Fruit, Vol. 29, 1934.
24. Prescott, Samuel C., "Bacteria as Affected by Temperature", Refrigeration Engineering, February 1932.
25. Telephone Directories for Knoxville, Nashville, Memphis, Chattanooga, Jackson, Martin, Johnson City.
26. Tennessee Valley Authority, "Frozen Fruit Demonstration, 1935: Strawberries", (Report Unpublished).
27. U. S. Agricultural Yearbooks, 1918 through 1935.
28. U. S. Department of Agriculture, Bureau of Agricultural Economics. Monthly issues of Crops & Markets, 1933, 1934, and 1935.

29. U. S. Department of Agriculture, Bureau of Agricultural Economics. "Carlot Shipments of Fruits and Vegetables from Stations in the United States, 1929-1935".
30. U. S. Department of Agriculture, Statistical Bulletins 13, 33, and 48. "Cold Storage Holdings".
31. Weigand, E. H., "The Frozen Pack Method of Preserving Berries", Oregon Agricultural Experiment Station Bulletin 278, 1931.
32. Woodroof, J. G., "Preservation of Fruits by Freezing: Peaches", Georgia Agricultural Experiment Station Bulletin 183, 1930.
33. Woodroof, J. G., "Experiments in Food Freezing", Refrigeration Engineering, June 1932.
34. _____ "Cold Pack Fruits", Western Canner and Packer, Statistical Number, March, 1935.
35. _____ "Frozen Foods", Facts in the Food Market, November 18, 1933.