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METHODS AND RESULTS OF RESEARCH IN MARKETING DAIRY PRODUCTS IN THE UNITED STATES

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IN PREPARING this paper, I have assumed that I could contribute most toward an understanding of our research work in the marketing of dairy products by citing a few of the research projects including a brief explanation of the sources of data in each case and some of the results at which we arrived. For certain reasons which are unnecessary to relate, I have chosen to limit this paper to the marketing of fluid milk and cream.

A PRELIMINARY SURVEY OF MILK MARKETING IN NEW YORK

The first study at Cornell of the economic phases of milk distribution was conducted in 1922-1924 by Dr. Norton and myself in cooperation with the United States Department of Agriculture. Very little work had been done previously in this field and practically no published material was available to suggest a method of approach to the economic problems of milk distribution. The investigation to which I refer, was primarily a statistical study of the consumption of milk in the New York market, the production of milk in the area tributary to this market, the uses of milk produced in this area, and the prices realized for milk utilized in various forms, such as fluid milk, cream, condensed milk, butter and cheese. The study also included a general outline of the process of handling milk for household consumption.

The major part of the data used in this study was obtained from statistical records in the State Department of Agriculture and Markets (to which reference will be made shortly), from a dairy trade paper, "The Milk Reporter" (which had published a monthly record of milk and cream receipts at the New York market since 1885), from published reports and office records of the Dairymen's League Cooperative Association, and from certain office records of one of the large firms engaged in the distribution of milk in New York City.

A report of this study was published in bulletin number 445 of the Cornell University Agricultural Experiment Station. I shall merely mention a few of the items of information given in this report.

SEASONAL RELATIONSHIPS BETWEEN SUPPLY AND CONSUMPTION
OF MILK

It was shown that in November and December there was only a small surplus above the market requirements, while in June, the supply was about double the quantity consumed as fluid milk or cream. This situation, together with the trends in production and consumption, indicated clearly the probability of an autumn shortage in the near future. Such a shortage occurred within two years after the study was made and has recurred each autumn since.

RELATIVE QUALITIES OF MILK PUT TO DIFFERENT USES AND
COMPARATIVE RETURNS FROM EACH USE

Prices quoted by the Dairymen's League for milk utilized in various ways by the purchasers, show that milk used for manufactured products such as butter or cheese generally yielded a much lower return than fluid milk while the returns on cream and condensed milk were also relatively unfavorable. These facts suggested the desirability of establishing a closer adjustment between the seasonal production and consumption of milk so as to permit a larger proportion of the total supply being utilized as fluid milk or cream. It was also shown that the seasonal scale of prices received by farmers for milk was such as to discourage the desired change in seasonal production.

MARGINS TAKEN BY DEALERS ON GRADE B MILK RETAILED IN
QUART BOTTLES IN NEW YORK CITY

The large margin taken by the distributors suggested the need for further study of the costs of handling milk between the farm and the consumer (table 1).

About the same time this study was made, Dr. H. A. Ross made a similar study in the Chicago market. His work differed from our own primarily in respect to the sources of data used. Since the available statistics of production and consumption of milk in the Chicago market area were extremely limited, Dr. Ross sought his data in the office records of the milk distributors. His analysis of the Chicago market was, therefore, less inclusive, but more intensive than our original study of the New York market. Dr. Ross's study of the Chicago market has been published in a bulletin of the Illinois Agricultural Experiment Station.

Before passing to a consideration of other research projects, I shall discuss briefly the dairy statistics of the New York State Department of Agriculture and Markets. This department has a bureau of statistics which is financed jointly by the state and the United States Department of Agriculture. The laws of the state require that all persons or firms who purchase milk or cream from farmers must be licensed and that they must keep records of the receipts and disposal of the milk, which records

Table 1. Prices, Freight Charges, and Distributors' Margins for Grade B Milk Retailed in Quart Bottles in New York City
(Cents per quart)

Year	Price at country plant	Freight	Distributor's margin	Retail price	Pool price for all milk
1922.....	6.1	1.1	7.4	14.6	4.7
1923.....	6.4	1.1	7.4	14.9	5.0
1924.....	5.6	1.1	7.3	14.0	4.3
1925.....	6.4	1.1	7.3	14.8	5.1
1926.....	6.5	1.1	7.4	15.0	5.4
1927.....	6.7	1.1	7.6	15.4	5.6
1928.....	6.9	1.1	7.6	15.6	5.6

are at all times open to inspection by officials of the State Department of Agriculture and Markets. The chief statistician of this department has taken a special interest in dairy records for many years and has developed a system of statistical reports which give a very large amount of useful information concerning the dairy industry of the state.

THE DEMAND SIDE OF THE NEW YORK MILK MARKET

Dr. H. A. Ross made a study of the demand side of the New York market during 1925 and 1926, in cooperation with the United States Department of Agriculture.¹ Most of the data were obtained from office records of several of the larger firms engaged in distributing milk in the New York market. Weekly sales figures covering a period of five years were obtained for each distributing branch so as to show the variations in consumption of milk as between districts of the city, as well as in point of time. Daily sales figures were obtained for certain districts. Supplementary information was obtained through the city Department of Health.

¹ Ross, H. A., The Demand Side of the New York Milk Market, Cornell University Agr. Exp. Sta. Bul. 459, July, 1927.

SEASONAL VARIATION IN SALES OF MILK AND CREAM

In the case of milk sales there was a steady increase from January to the first week in July. Then followed an abrupt decline during the vacation period, with some recovery in early September, as vacationists returned to the city. With approaching cold weather, sales declined through the remainder of the year.

Cream sales increased from a low point in January to a peak the first week in June, this being the season for berries and cream. The sales remained high during June but began a decline in July due to vacations, which continued throughout the remainder of the year. It should be noted that a large amount of cream is used for ice cream, of which the sales are very much greater in hot weather than at other times.

EFFECT OF TEMPERATURE ON WEEKLY SALES OF MILK²

The effect of temperature on weekly sales of milk is shown in figure 1. Sales of Grade A milk were least affected by changes in temperature, while bulk sales of Grade B milk—used largely as extra supplies for drinking—were affected most. The correlation between the maximum temperature on a given day and sales the following day was quite high during the summer months. In August, this correlation coefficient for bulk milk was $+0.814$. Sales of products consumed by adults are affected to a greater degree by temperature changes than are products consumed largely by children, such as certified milk and Grade A milk. Considering all classes of milk, sales, on the average, were 7 per cent above normal when the temperature was 20° above normal.

Accurate statistical measurements of the variations in sales of milk due to temperature changes, day-of-the-week, holidays, and the like, are useful to the distributors in determining the quantity of milk and cream to be put up in bottles of various sizes for the following morning's deliveries. This permits a saving in labor and other expenses and also a reduction in the quantity of bottled milk returned from the routes which must be used for butter or some other by-product which usually yields a very low return. In this study, Dr. Ross has demonstrated a method of forecasting sales of milk and cream, either for the short term of one or two days, or a week, or for a period of months or years.

² Six summer months, April to September inclusive.

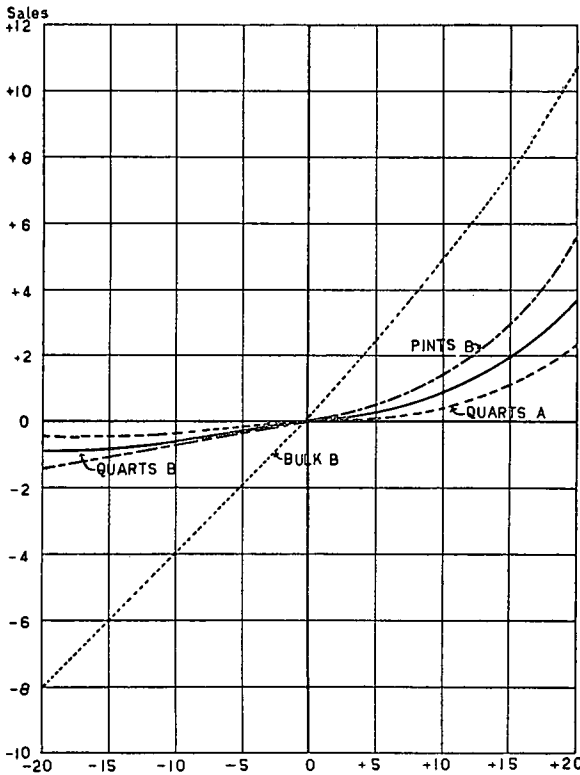


FIGURE 1. EFFECT OF WEEKLY TEMPERATURE CHANGES ON THE RETAIL SALES OF MILK IN THE NEW YORK METROPOLITAN AREA

Average weekly temperatures and sales are expressed as percentages of the average for the preceding three weeks. When the temperature rises, sales increase, and when the temperature falls, sales decrease.

EFFECT OF PRICE CHANGES ON SALES OF MILK

In general, for the period covered by this study, a change of one cent per quart had relatively little effect on sales, but an increase of 2 cents per quart at one time, had a much more pronounced effect. One important conclusion from this study was that moderate increases in the retail price of milk do not seriously curtail the sales provided consumers are accustomed to reasonably frequent changes in the price. For 9 years previous to 1916, the retail price of milk in New York remained stationary at 9 cents per quart. The result was that consumers became very

strongly accustomed to this price and a serious disturbance of the industry, including a producers' strike, was necessary to bring about a change.

The facts brought out in this study covering the effect of price changes on sales of milk have very effectively destroyed a stock argument of the distributors against milk price increases, when such increases are justified by economic conditions.

A STUDY OF THE SUPPLY OF MILK AND CREAM FOR THE NEW YORK MARKET

A study of the supply of milk and cream for the New York market has been in progress for the past two years and is now nearing completion.⁹ It is being made in cooperation with the New York Central Railroad which is the largest carrier of milk to the New York market. Most of the data have come from office records of the firms that operate country receiving stations or dairy manufacturing plants. Use also was made of the census and of the statistics, previously mentioned, that are compiled by the State Department of Agriculture. Much of the data covers a period of several years, and the record is nearly complete for the past five years. The records are being tabulated by machine. A brief summary of one phase of this study is shown in table 2.

Table 2. Number of Dairies and Production per Dairy in June and November, 1927 Supply Area for the New York Market

Grade of milk	Number of dairies	Daily production per dairy		Per cent which November production was of June production
		June	November	
Grade A.....	6,244	400	271	68
Grade B.....	46,099	321	148	46
New York unapproved.....	3,961	218	123	56
Manufactured on railroad.....	5,786	235	118	50
Manufactured off railroad....	7,992	249	86	34
All dairies.....	70,082	305	149	49

Grade B is the common grade of milk sold in the New York market. The production of milk on Grade B farms was less than half as much in November as in June, but Grade A dairies

⁹ Ross, H. A., A Study of the Supply of Milk and Cream for the New York Market. Unpublished.

produced 68 per cent as much in November as in June (table 2). This difference is due in part to the location of the Grade A receiving stations, and in part to the higher premium paid for Grade A milk of low bacteria count during the autumn and winter.

Of the 70,082 dairies included in this tabulation nearly 14,000 were supplying milk to dairy manufacturing plants which had not qualified for the New York market. These dairies produced about 16,000 ten-gallon cans of milk daily in November. Not all of this milk can be made available for the New York market but the data relating to the total quantity and location of such milk are very useful to cooperative and private organizations which are endeavoring to provide adequate supplies for New York without opening up entirely new territory. Another important fact shown by this study is that since the war, no progress has been made in adjusting the seasonal production of milk more closely to the market requirements. Serious thought is now being given to the question of seasonal price arrangements to stimulate greater production of milk during the autumn and early winter.

RELATION OF THE BASIC-SURPLUS MARKETING PLAN TO MILK PRODUCTION IN THE PHILADELPHIA MILK SHED

A study has been made with the object in view of determining what effect the seasonal rating plan of milk prices has had on the production of milk in the Philadelphia milk shed.⁴ Under the seasonal rating plan, the average quantity of milk delivered by each farmer during October, November and December is taken as his basic quantity for the ensuing year. For this quantity he receives the "basic" price. For additional quantities he receives a price based on the price of butter, which is considerably lower than the basic price. The general effect of this plan, which was adopted in 1919, has been to stimulate much larger production in the basic months and a reduction of the surplus in other months.

The data used in this study were obtained from records of the milk producers' cooperative association, from cow testing association records on file at the College, and from questionnaires mailed to the dairymen concerning feeding practices and similar matters. The results show that in general, the farmers with little or no

⁴ Lininger, F. F., The Relation of the Basic-Surplus Marketing Plan to Milk Production in the Philadelphia Milk Shed, Pennsylvania Agr. Exp. Sta. Bul. 231, August, 1928.

permanent pasture, had done most in the way of equalizing their production, while those who had a high ratio of pasture to cropland, had not responded to the premium paid for equalized production. The study gives interesting facts as to the changes in herd management and in costs brought about by the basic-surplus price plan. As between producers who were operating under the seasonal rating plan and other producers in the same area, there was only a slight difference in the cost of producing 100 pounds of milk (\$2.017 per hundredweight against \$1.991).

COSTS OF HANDLING FLUID MILK AND CREAM IN COUNTRY PLANTS IN NEW YORK STATE

The data for the study of costs of handling fluid milk and cream in country plants came almost entirely from the office records of several firms that operate country receiving stations and dairy manufacturing plants in the New York market area.⁵ Detailed information and measurements, necessary to making a distribution of costs, were obtained by personal visits to the plants. The total number of plants included in the study was 83. The officials of each firm assisted us in selecting for study a group of plants representing a variety of conditions as to annual volume of milk received, seasonal production, labor saving equipment, processes carried out in the plant, investment in buildings and the like. The 83 plants included 38 plants shipping raw milk in 10-gallon cans, 18 plants shipping pasteurized milk in cans, 15 plants shipping pasteurized milk in bottles, 10 plants shipping cream, and two plants manufacturing miscellaneous dairy products.

The raw milk plants and bottling plants included in the study proved to be somewhat larger, on the whole, than the average size of such plants in the territory, but the pasteurizing plants were of average size.

A summary of the costs for 38 raw milk plants, which are the most common type of plant operated in the New York territory, is given in table 3. It is to be noted that wages constituted over 40 per cent of the total cost. This suggests that in seeking ways to reduce costs, labor efficiency should be given first consideration. Interest was included in the costs, although in their accounting some firms did not include it. In any study which is primarily

⁵ Tucker, C. K., *Costs of Handling Milk and Cream in Country Plants*, Cornell Univ. Agr. Exp. Sta. Bul. 473, January, 1929.

Table 3. Costs of Operating Raw Milk Plants in New York State (Average for 38 plants with an average volume of 2,270 gallons daily)

	Cost per plant		Cost per 100 pounds of milk (cents)
	Amount	Per cent of total	
Labor, direct and indirect.....	\$6,894.28	42.7	9.8
Coal.....	1,123.78	7.0	1.6
Ice.....	1,289.62	8.0	1.9
Other supplies.....	1,028.57	6.4	1.5
Electric power and light.....	237.57	1.5	0.3
Miscellaneous costs.....	1,470.24	9.1	2.1
Building depreciation.....	589.73	3.6	0.8
Building repairs.....	652.92	4.0	0.9
Equipment depreciation.....	916.76	5.7	1.3
Equipment repairs.....	329.12	2.0	0.5
Taxes.....	313.90	1.9	0.4
Insurance.....	306.35	1.9	0.4
Rent.....	90.23	0.6	0.1
Interest at 6 per cent:			
On land and buildings.....	508.00	3.1	0.7
On equipment.....	343.78	2.1	0.5
On supplies.....	69.26	0.4	0.1
Total.....	\$16,164.11	100.0	22.9

an analysis of the differences in costs between plants, or any other business unit, it is absolutely necessary to include the interest item in order to arrive at sound conclusions.

In another table is shown the relation of the volume of milk handled per plant to the unit costs of operation (table 4). In one group of 14 plants none of which received more than 4,000,000 pounds of milk for the year (average of 900 gallons per day) the cost per 100 pounds was 33 cents. In another group of plants

Table 4. Relation of Volume of Milk Handled per Plant to Cost per 100 Pounds, 38 Raw Milk Plants in New York State

	14 900	12 1,760	12 4,390
Costs per 100 pounds of milk:	(cents)	(cents)	(cents)
Land and buildings.....	6.4	4.3	2.6
Equipment.....	4.0	2.8	2.3
Direct labor.....	11.9	9.9	8.5
Supplies.....	8.1	5.8	3.9
Miscellaneous.....	2.6	2.6	2.3
Total.....	33.0	25.4	19.6

each of which handled more than 8,000,000 pounds for the year (average of 4,390 gallons per day) the cost was only 19.6 cents per 100 pounds. In nearly all of our studies of cost, whether of milk plants, fruit packing houses, feed stores, or other lines, the volume of business done has been the most important factor affecting the efficiency of the unit. In fact, this one factor usually has such great importance that it is difficult to measure the influence of other related factors. In the case of milk plants, other conditions which were found to influence the unit costs were the amount invested in plant and equipment; arrangement of the plant with particular reference to labor efficiency; seasonal receipts of milk, and the method of refrigeration. Ice machines were found uneconomical in plants receiving less than 8,000,000 pounds of milk per year and electric driven ice machines were found more economical than steam driven machines. When the costs were segregated according to processes, it was found that the cost of cooling the milk constituted one-fourth of the total, and the washing of cans nearly an equal amount. The cost of pasteurizing milk in plants that shipped pasteurized milk in cans was 5.9 cents per 100 pounds, or approximately one-eighth cent per quart.

A STUDY OF THE COLLECTION OF MILK AT COUNTRY PLANTS IN NEW YORK STATE⁶

An investigation of the collection of milk at country plants was carried out at the same time as the study just described and was very closely related to it. It was apparent to us that many country milk plants were being operated throughout our state which were not required under modern conditions of transportation in the rural communities. We, therefore, undertook this study in order to obtain accurate data regarding the conditions and costs of hauling milk, and the possibility of reducing the combined costs of hauling, plant operation, and shipping, by eliminating superfluous plants.

The average cost of hauling milk by individual farmers was 75 cents a trip or 25 cents per 100 pounds. The hauling cost per 100 pounds of milk was much less for loads of 300 pounds or more than for smaller loads.

These figures emphasize the relative inefficiency and high cost

⁶ Spencer, Leland, *An Economic Study of the Collection of Milk at Country Plants*, Cornell University Agr. Exp. Sta. Bul. 486, June, 1929.

involved in hauling small loads of milk. A number of the dairymen interviewed were increasing the size of load by hauling for neighbors, either on a cooperative basis or for hire.

The average cost of hauling milk on the 76 commercial routes was \$3.64 per trip or 17 cents per 100 pounds. The average load was 2,090 pounds. The cost per 100 pounds of milk decreased as the size of the loads increased. In spite of the longer haul for the routes with large loads, their unit costs were much lower than those for smaller routes. It was evident in many cases that competition between routes, and between routes and farmer-hauling, was increasing the total costs of hauling to a marked degree. The suggestion was made that the proprietors of the plants might take the responsibility for collecting the milk, letting exclusive contracts to haulers so as to reduce the cost.

In comparing the costs of hauling by individual dairymen with the charges for hauling on the commercial routes, it was found that the commercial routes were cheaper, especially for the longer distances, that is for distances of 3 miles or more.

For one area a careful analysis was made of the probable effect of eliminating certain of the plants, upon costs of hauling the milk, costs of plant operation, and costs of transportation by rail. The conclusion reached was that a large proportion, perhaps one-half of the country milk plants now in operation, could be eliminated with a considerable saving in costs and without causing serious inconvenience to the farmer.

Maps were made showing the location of farms supplying milk to 56 country plants in three different areas in the state. The distance on improved road and unimproved road from each farm to the plant was determined from these maps. A 12-month record of the milk delivered by each farmer was obtained from office records of the proprietors of the plants. A list was prepared for 20 plants showing the method of delivering the milk, whether individually or by custom hauling, and the kind of vehicle used. This information was furnished by the plant managers. Detailed estimates of the costs of hauling milk were obtained from 204 dairymen who hauled their own milk, and from 76 commercial haulers.

The choice of these locations was based on the results of our detailed study of milk hauling in the limited areas and upon information obtained from the county agricultural agents. The

number of locations thus selected was only half as great as the number of plants now being operated. It is our thought that by presenting to the proprietors of the milk plants and to the farmers the facts as to these opportunities for reducing costs, progress in this direction will be made more rapidly.

COSTS AND MARGINS AND OTHER RELATED FACTORS IN THE
DISTRIBUTION OF FLUID MILK IN FOUR ILLINOIS
MARKET AREAS

The data for a study of costs, margins and other related factors in the distribution of fluid milk in four Illinois market areas were obtained from office records of the larger distributors in four cities of Illinois.⁷ Production, transportation, processing, sales and cost records were among those examined. Supplementary data were

Table 5. Per Capita Consumption of Milk and Cream in Chicago, St. Louis, and Peoria

	Pints daily	Per cent	
		Milk	Cream
Chicago:			
Milk only, November, 1927801	70	30
St. Louis:			
Milk only, December, 1927666	75	25
Peoria:			
Milk and cream, December, 1927681	80	20

Table 6. Summary of Margins and Costs, Chicago, 1925-1926
(Basis of one quart of 3.5 per cent milk)

	(cents)	(cents)
Customer's purchase price		12.9
Cost of milk		5.3
Gross margin		7.6
Purchasing, receiving, and processing expense	2.2	
Selling and delivery expense	4.6	
General and administrative expense	0.3	
Total expense		7.1
Net income		0.5

⁷ Brown, C. A., Costs and Margins, and Other Related Factors in the Distribution of Fluid Milk in Four Illinois Market Areas, Illinois Agr. Exp. Sta. Bul. 318, December, 1928.

Table 7. Unit Profits and Losses on Retail Milk and Cream, Chicago, 1924

	Unit profit or loss (cents)	Equivalent per quart of 3.5 per cent milk (cents)
Whole milk:		
Quarts.....	+ .752	+ .752
Pints.....	- 1.560	- 3.170
Half-pints.....	- .936	- 3.744
Sweet cream:		
Half-pints—22 per cent.....	+ 1.730	+ 1.100
Half-pints—32 per cent.....	+ 2.060	+ .900

obtained from the federal census reports, municipal departments of health and the like. Certain of the results of the study are given in tables 5 to 7.

SUMMARY

In general, investigations of the marketing of dairy products may be grouped under three headings:

1. Preliminary surveys to get facts and to make contacts which can be used as a basis for more detailed studies.
2. Investigations relating to the adjustment of supply to demand.
3. Investigations relating to costs and efficiency of distribution.

The last two in particular should have definite objectives at the start.

One test of the usefulness of such studies as have been mentioned is the attitude of the officials of commercial dairy organizations toward them. That their attitude is favorable is clearly indicated by the fact that they have offered attractive positions to the investigators and that two of the investigators mentioned are now employed by organizations that furnished data for their studies.

DISCUSSION OF DR. SPENCER'S PAPER

Mr. Prewett.—Dr. Spencer's survey covers ground that we have hardly been able to touch. It is safe, however, for us to make several generalizations. Retail prices, prices to farmers, and margins have a very close relationship to our own. We were first led to believe that large urban markets in England were supplied direct and not thorough depots. With the exception of three large towns, all are situated in intensive dairying districts. Newcastle, Hull and London are supplied by depots. Railways carry five million tons of milk a year. There is a marked increase in consumption in summer. Ice cream is not nearly so prevalent in England

as in the United States. Seasonal fluctuations in the United States are much more extreme than ours.

Dr. Spencer.—It is possible that seasonal fluctuations may be accounted for by greater extremes in climate. The effect of selling milk at classified prices according to its use, has resulted in a higher price to farmers during the summer months.

Professor Ashby.—On one or two occasions when the price of milk has been increased in this country, demand has dropped and within a week or two retailers have had to drop the price.

It is important to have more information than we now have about demand in this country, especially seasonal demand. Some London firms have a steady demand throughout the year. When we get a true sample of the whole country, we may have to revise our opinions. It occurs to me that if Prewett's statement as to the regularity of demand is correct, dealers would have to put down the figures in the process of negotiation with producers.

Professor Case.—It seems that the question of dealers' margins is a vital one with farmers in any dairy region. From an Illinois study made during the past year it was found that farmers were getting a smaller share of the retail price of milk than the distributors. It was even found that the wagon drivers were getting a larger rate per quart of milk delivered than the farmers received for the product when it left their farms. Even after this information was furnished, some farmers still expressed some dissatisfaction with the research because the figures did not show how large the salaries were which were paid to management by milk distributors. It appeared, however, that the item of cost which was farthest out of line was the share of the retail price taken by the wagon drivers. This is leading to some consideration by farmers of taking over the distribution of their product.