TERRE HAUTE MILK--FROM PRODUCER TO CONSUMER

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SCOPE OF STUDY

I. PROBLEM

As the population per unit area increases and greater concentration occurs, the economic problems of society become more and more complex. Greater specialization of occupations and cleavages in the social organization occur. Accompanying these large and, at the moment, indistinct tides are myriads of small problems which are very distinct and concrete and which touch the daily lives and work of individual citizens. These growing pains in the metamorphosis of society are usually very irritating to the individuals immediately affected. One of such pains is the acquisition of a wholesome and palatable milk supply in the large urban areas.

Many studies of milk quality and quality-control have been made. The work of the United States Public Health Service, the state health departments, local health commissions, and the more progressive milk processing and distributing companies have made available to all people, milk in fairly healthful condition. However, a study made by Rukes[1] in the Terre Haute, Indiana, milk market showed this supply to be

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[1]Max Rukes, "Survey of Terre Haute, Indiana, Milk Supply," Thesis Number 194, Indiana State Teachers College, 1942.

far from ideal. His study like most others dealt with the final retail product, however, and did not attempt to seek out the detailed processes in the handling of milk where the break in quality occurred.

It is the purpose of this report to supply that information. It is done with the belief that if the trouble spots are positively pointed out they will be corrected by those responsible for them. The dissension and bitterness found in the relationship of the Board of Health, milk distributors, wholesale agency, and farmer-producers could be eliminated if each knew exactly where the fault or faults actually were. The tendency "to alibi" and to blame others would be stifled. This study would have been impossible without the cooperation given by a milk distributor and several progressive and scientific-minded farmer-producers. Commendation is extended to the Borden Milk Company, Terre Haute Division, David Siloto, Oliver Blair, Fred Adams, Harold Taylor, Glenn Williams, Clarence Mann and Son, Don Akers, Dr. Don Gerrish, Cecil Bostick, Webb Stultz, and Raymond Stultz. Their concern is to place in the hands of the urban consumer a good specimen of nature's finest food, clean wholesome milk.

II. MILK PRODUCTION

At the time of this writing four major distributors

are supplying the bulk of whole milk, butter, ice cream, and cottage cheese in Terre Haute. The largest is the Terre Haute division of the Borden Company. Model Milk and Ice Cream Company is second in volume of business and next in production are Bettenbrock Dairy and Wabash Valley Dairy. Borden's and Model account for approximately ninety-five per cent of the entire supply. Model's business is approximately sixty-five per cent of that of Borden's. Thus it can be seen that the Borden Company accounts for approximately fifty-seven per cent of the Terre Haute volume. It follows that an analysis of its problem is an analysis of the major portion of the milk problems of that area.

The second factor bearing on the quality of milk is the gross tonnage of milk brought directly to Terre Haute from the farms. Focusing a large stream of milk from many sources into two plants is in itself a hazard to milk quality. In the summer flush season, when the highest daily volume of milk is produced, approximately sixty tons of raw milk is collected from farms and transported in cans to the distributing plants. Adverse winter conditions affecting the cows cut this supply to approximately thirty tons daily. Some five hundred farmer-producers marketed by this method a gross volume of thirty million pounds of milk in nineteen forty-five. These farmers reside in six counties near Terre Haute:

Parke, Clay, Vigo, and Sullivan counties in Indiana, and Edgar and Clark in Illinois (and a relatively small volume from Crawford County, Illinois.) Thus, it can be seen that this milk-shed covers a circle with a radius of approximately twenty-five miles.

Compared with advanced markets the general farm conditions from the standpoint of dairying are poor. Not more than eight per cent have milk houses to care for milk and milk equipment. The bulk of the barns are antiquated and badly in need of remodeling. For the most part they are of the design most used in the first decade of the twentieth century. However, most of them have concrete floors under the cows. About one-half of the farms are served by electric power lines, but fewer have power in the barn. Most milking is done by hand, and the milk is usually filtered directly into the shipping can at the barn. Milk utensils are washed in the kitchen with soap. The shipping cans are not usually washed or sterilized more than is done at the distributing plant before they are returned to the farmer. Cows' udders are not washed. It should be obvious that these are general statements and by no means do they apply to all farms. These observations, however, are the result of several years of intimate contact with the producers in this area. Much progress has recently been made by the farmers as a result of

the milk grading ordinance of the city of Terre Haute, incorporating the principal features of both the state and federal codes. But, as will be demonstrated, the farmer is by no means the only agent responsible for the low quality of retail milk. He has been subjected to undue criticism by those other agencies that are reluctant to improve their own methods of handling.

III. MILK MARKETING METHODS

It is essential to an understanding of the milk quality problem to gain an insight into the details of getting the milk from the cow to the consumer. The stagnation of the program is due in no small degree to the attitude prevailing among the handlers of milk. It could be summed up by saying that all are pointing accusing fingers at the farmer. Regardless of what care, or lack of care, poor transportation facilities, long delay in getting the milk to market, and lack of quick pasteurization, if the milk is not of good quality when it at long last is received by the pasteurizer the farmer gets the blame. And, incidentally, the good barns do not insure good milk. The farmer is expected to assume all responsibility for the quality of his milk until it is checked by the man who receives it at the distributing plant. Thus, the milk he draws at six o'clock this evening may not be

checked in at the plant until as late as three o'clock to-morrow afternoon, a wait of twenty-one hours. Raw milk should be processed within three hours after it leaves the udder, but sooner if possible.

In the Terre Haute milk-shed the bulk of the milk is transported from farms to plants by professional haulers. All haulers except two, at this writing, use open flat-bottom truck bodies for this purpose. The cans are arranged on this platform exposed to rain, snow, sun, and dust until he completes his route. The routes vary in load and length. They average seventy miles in overall distance, round trip. Each hauler serves an average of thirty farms. His milk load varies from two thousand to eight thousand pounds daily. He is the principal laison between the city milk market and the farmer-producer. He is paid for hauling by the hundred-weight whether the milk is accepted or rejected.

Milk is marketed in Terre Haute through a corporation organized under the nineteen twenty-five Indiana cooperative marketing law. The company is governed by a board of five directors elected to three-year terms by the membership. Any one whose milk is sold under contract is a member. Authority for management is delegated to a general manager. His duties are such as are authorized by the board. The distributing dairies account to his office for all milk marketed; and he

arranges payment, after deductions, to the producers. Deductions include office and hauler expense. The haulers consider their routes entirely independent of the cooperative corporation. In theory this type of marketing could be efficient and beneficial to all concerned. Practice is another story.

No definite analyses have been made of milk sent to the plants in Terre Haute. Grading has been and still is grossly inadequate. In the past, milk has been accepted or rejected wholly on the odor. Recently however, one dairy has made good use of the methylene-blue reductase test to report objectively individual producer samples. Another is using an acid indicator concentrated to detect acidity higher than seventeen and one-half parts per thousand (which it considers unfit). The plants also determine the butterfat content of the individual producer's milk and account to the wholesale corporation for its value. Thus it can be seen that the burden of selection and processing is entirely on the distributor, but he is not free to initiate a program of milk improvement because his authority begins when the milk arrives at his plant. The damage has been done before it comes to him. The care of milk up to that time is definitely in the field of the wholesale marketing agency. The distributors are cooperating with the municipal milk-grading program in the hope of getting a good supply of wholesome raw milk.

IV. DIFFICULTY OF CONCERTED ACTION

The farmer-producer who supplies Terre Haute's milk has been for years without objective reports on the quality of his product. Rejection was based only on two vague decisions, "sour" and "off odor". He has had no way of knowing what the difficulty was. He was merely blamed for "not taking care of it". His questions were answered by the hauler who constantly propagandized to further his own interests. The farmer has come to distrust the distributor who buys his milk, to hate the officials of the cooperative, and to resent the encroachments of the board of health. All these attitudes can be ascribed to one cause, namely, lack of information. It is hoped that this study will not only supply such knowledge but also point the way to further enlightenment. If radical changes must be made in the marketing system in order to supply good milk, then those changes must be based on accurate knowledge of the various factors influencing milk quality. The time for finger pointing has passed.

The position of the milk haulers in the marketing process is a pivotal one. They hold a virtual monopoly over the Terre Haute milk supply. Despite the beautiful theory of the farmers' marketing cooperative the real power in that organization is in the hands of the haulers. They manipulate the election of the board of the directors and lay down company

policy. They are able to incite the farmers against a quality program and do. They are able, through union affiliation, to dominate distributor activities. Thus, any program to improve the milk supply must first penetrate this "Maginot Line." Through fear of loss of market and propaganda the farmer is at their mercy. Through political maneuvering the cooperative is an instrument in their hands. Through union power the distributors are kept at bay. And by a solid front the board of health is "stymied".

As was previously pointed out, the cooperative marketing system could perform a wonderful service. It could stabilize prices, eliminating cut-throat buying. It could provide the best and most coordinated pick-up of farmers' milk. It could carry its own program of quality guarantee, thus expanding its market with a superior product. It could provide a herd-development program, keeping farmers abreast of the times. It could provide services such as barn spraying, seed buying, milk testing, artificial insemination of dairy cattle, and numerous other activities of a progressive nature that are difficult for the farmers to obtain as individuals. It could perform these services if it were a real cooperative, but it is far from it. It is little more than a check-off agency assuring the maintenance of the hauler monopoly. Wabash Valley dairymen get less for their milk, pay a higher hauling rate, get the most in-

effecient hauling, and receive fewer services than dairymen in any comparable milkshed in the United States.[1]

Distributors are continually subjected to the pressure of consumer criticism. They are also the object of scrutiny by those who are scientifically qualified to understand the problem and those who are merely interested in good milk. For these reasons distributors are hard pressed to place a good product on the market, but the product retailed can be little better in chemical make-up than the raw product received. To be sure, bacteria can be killed; but their ravages on the life-giving ingredients can not be repaired. Incentives, such as more pay for higher quality, can not be resorted to under present cooperative policy. For the same reason field work can not be done by distributors. In short, all that the plants have been able to do is test, and accept or reject. This practice is just about as effective as not meeting students at all during the school year, but calling them in for examination at the end of the term and passing or failing them. Development has been practically non-existent.

In January, nineteen forty-five, the city of Terre Haute instituted a milk grading ordinance based on the nineteen twenty-five United States Public Health Milk Code and the Indi-

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[1]Monthly Report, National Cooperative Milk Producers Federation, June, 1945.

ana State Board of Health Milk Code. One year was allowed for a developmental program. No farm study had been made previously. Neither an overall nor a detailed survey of the marketing methods had preceded its passage. Emphasis was and still is placed on suitable building facilities. Progress is being made, but the enforcement date had to be postponed indefinitely. Terre Haute is still a long way from Grade "A" milk.

CHAPTER II

EFFECTS OF HANDLING ON MILK QUALITY

I. GENERAL PROCEDURE

It was assumed in planning this study that nothing is understood by an overall view. It is essential that a detailed and objective report be made of those qualities and factors in handling milk which affect the ultimate product. Although other factors such as food of cows, foreign aromas, and contact with other matter, greatly influence the quality of milk, analysis of those factors is not attempted in this study. Only the quantitative bacteria analysis and those factors which were presumed to affect it were studied. No attempt was made to classify the bacteria present in the milk samples. Whereas, the milk in the udder of the cow is relatively bacteria free, the presence of myriads in the commercial milk is presumed to be due to their multiplication at the expense of the nutritive ingredients of the milk. Conditions favorable to the development of bacteria have been known to bacteriologists since the time of Louis Pasteur. They are inoculation of media, optimum temperature, and time. Therefore, it behooved this investigator to measure those elements as they existed in the Terre Haute market.

The help of a local dairy-products distributor was sought and was enthusiastically given. Milk samples were to be taken at the receiving tank of the plant where the farmer's milk enters

the plant. Other samples were to be obtained in the large temporary holding vats from which the milk is proportioned to the various processes in the preparation of dairy products, such as whole milk, chocolate milk, butter, ice cream, cottage cheese, and coffee cream. Still other samples were taken immediately after pasteurization, and final samples were taken at the retail outlets of this distributor. A bacteria count of these samples was compared with those taken at the farm. In this manner the path of bacteria development and control was traced.

Temperature at the plant was rigidly controlled, but the heat factor of the raw milk was a vital one. Therefore the milk temperature was measured at the farm and when the milk arrived at the distributing plants. In most instances it was not feasible to determine the temperature of a farmer's milk at the time it was placed on the truck for transporting to city market. The temperature at which the farmer held his milk over night was checked, however. In as much as the samples were taken at morning milking time, most morning temperatures are approximately body temperature of the cow.

Time is a vital factor in bacterial development, just as it is in all biological processes. Therefore it was essential to an objective study that the element be considered. It was ascertained how much time had elapsed from the moment milk was

drawn from the cow's udder and the sample was taken. Also, to get a true picture of the effect of transportation of raw milk upon its quality the delay between morning milking and arrival at the plant was checked.

It is apparent that this study necessitated visits to farms at milking time. Ten farmer-producers consented to aid in this study. General farm facilities for handling milk were observed. Five night samples and five morning samples were collected at each farm. The temperature of the held-over night milk was taken as was that of the morning milk.

Samples were immediately plated. Then the testor met the truck coming in to the plant with the milk from the farms where the samples had been collected. The milk temperature was taken, time of arrival noted, and another sample collected. To throw some light on the relative merits of closed, insulated truck bodies and open-platform bodies, the samples to be studied were taken evenly from the two types of trucks. Thus, farmers on a closed-truck route and those on an open-truck route were visited on the same day. Immediately after a sample was taken, it was chilled and taken to the laboratory and plated. It will be noted that the temperature credited to the milk upon arrival at the plant was the temperature of the milk drawn the night before. It was not known at what temperature morning milk was placed on the truck, but the milk sample for

counting was a composite night and morning sample. In all, there were fifty night milk and fifty morning milk samples taken at the ten farms. Each farm was visited five successive days. One composite night and morning sample was collected at the plant from each farmer's milk on the same day that his farm sample was taken. Fifty holding-vat samples and a like number from each the bottler and retail outlet were taken. All told some three hundred milk samples were collected in the course of this investigation. This quantity of data insures reliability.

II. REPRESENTATIVE MILK PRODUCERS

An earlier survey made by this writer furnished the data to support the previous statements as to the general farm conditions in the Terre Haute area. Having become familiar with the general picture, it was not difficult to select for this study farmer-producers representative of the Wabash Valley dairymen. Sacrifice was made, however, in order to use those farms strategically located according to two other criteria. First, it was necessary that they be located on two milk routes, one group of five sending their milk in an insulated closed truck and the other five shipping in an open flat-bottom truck. Second, for the purpose of quick laboratory analysis, the producers must be near enough together to eliminate delay in col-

lecting samples.

Producer Number 1 owned his own herd and farm sixteen miles from Terre Haute. Electric utilities were used in all farm buildings. The cows were milked by an electrically powered milker. The barn was in the process of modernization. The milk and utensils were cared for in an approved milk house and cooled by water in a concrete tank. The tank was not covered. In the care of utensils, use was made of good cleansers and chlorine sterilizers. Cows' udders were washed prior to milking. In a general way the farm conditions were good, and this dairyman was preparing to produce Grade "A" raw milk. His milk was transported in a truck equipped with an insulated closed body.

Producer Number 2 lived on his own farm and cared for his small herd of registered Guernseys. His barn was old and unpainted but the cows were milked in a section with a concrete floor. There was no milk house. Utensils were cared for in the kitchen and the milk was filtered and cooled in the barn lot. The milk was drawn by hand. Cows' udders were not washed before milking. His milk was sent to market in a closed truck. The farmer and his wife were personally clean and the farm was neatly kept.

Producer Number 3 milked by hand in an insanitary barn and filtered his half can of milk outside the barn lot. Cooling

was done in clay tile sewer with a concrete bottom, all above ground. The milk was filtered by a cloth, and there was no evidence of chlorine or soapless cleansers. His milk was sent in an open truck.

Producer Number 4 had a new approved barn and milk house. The milk house is equipped in accordance with state and local health recommendations. Milking is done by an electrically operated milker and mechanically cooled. Number 4 ships his milk on an open truck. His farm, as were the other three, is approximately seventeen miles from Terre Haute.

Producer Number 5 is a breeder of registered Guernsey cattle. His barn is good but not quite up to Grade "A" specification. He milks by means of an electrically operated milker and cools the milk in an open tank in the barn lot using water from a power pump. Utensils are washed in the kitchen. On the whole, the farm conditions are good and in the process of meeting Grade "A" standards. His milk is shipped in an open truck.

Producer Number 6 owns his farm and herd which are located seven miles from the city. A description of his barn and milk house would be unfair because they were in the process of construction at the time the samples were taken. They will be state approved. The milk was drawn by means of a portable, electrically powered mechanical milker and mechanically cooled.

He shipped to market on an open truck.

Producer Number 7 was a tenant farmer operating a very modern dairy plant. Approved methods of cleaning and sterilizing milk equipment were used, and the milk was mechanically cooled. Transportation was by means of an insulated closed truck. The farm was located six miles from Terre Haute.

Producer Number 8 lived seven miles from Terre Haute. His barn was old and unpainted. The milking barn was concreted, but the cow lot was insanitary. The milk was drawn by hand and was filtered at the well tank near the house seventy yards away. There was no milk house. The milk was cooled in a tank at the well and the utensils were cleaned in the kitchen. The family was meticulous in the care of milk. He shipped on a closed truck.

Producer Number 9 owned an old barn with a well concreted cow section but unsealed from the rest. He was located eighteen miles from Terre Haute. The milk was drawn from an excellent herd of Guernsey cows by an electrically operated milker, and cooled in an outdoor watering tank. Milk utensils were cleaned in the kitchen by means of approved cleansers and sterilizers. The cows' udders were washed prior to milking. The family is clean in spite of poor facilities. The milk was shipped in a closed truck.

Producer Number 10 lived ten miles from the city. Elec-

tric power was available, but he milked by hand. He owned an excellent herd of Jersey cows which were housed in a good barn. No milk house was present. Milk was filtered and cooled in a well house and the utensils were cleaned in the kitchen. Approved cleansers and chlorine sterilizers were used. He shipped on an open truck.

It can be seen that these farmer-producers were an excellent representation of the Wabash Valley patrons.

III. QUALITY ANALYSIS PROCEDURE

Milk, especially raw milk, is a commodity that must be marketed rapidly. It is the most perishable of all farm products. There is no "ripening" stage as in fruit prior to which it can be harvested and marketed before it reaches its perfect food value. It is produced twice daily. It is a perfect food immediately. It can not easily be preserved. Its goodness is inversely proportional to its age. It steadily grows worse. To be sure, some conditions can be maintained which will retard deterioration; but no condition of handling can improve it. Therefore a study of time, temperature, and exposure will provide the key to quality--stabilization and the inhibition of bacterial deterioration of milk.

As was previously pointed out, the dairy farm had to be visited at milking time to make this study. Numbers 1, 2, 3,

and 4 were visited each morning for five consecutive days. At each farm, while the farmer was milking, a sample of freshly drawn milk was placed in a sample-bottle and submerged in ice water. The temperature of the fresh milk was checked by means of a floating Fahrenheit dairy thermometer. A like sample and temperature check was taken from the previous night's milk which was in the shipping can near by. In Table I the letters in the "Sample" column represent individual samples of milk. The time in hours beside them indicates how much time had elapsed from the drawing of the milk to the plating of the sample. Thus, sample "a" of Producer Number 1 had been held by the producer fourteen hours at a temperature of sixty-two degrees when the sample was plated. It will be apparent that such milk was the previous night's milk. Sample "b" was held two hours at ninety degrees average Fahrenheit temperature. Sample "a" contained one hundred fifty thousand bacteria per cubic centimeter. Likewise in each producer bracket, a, c, e, g, and i are samples of milk held overnight and collected in the morning; and b, d, f, h, and j indicate freshly drawn morning samples.

After the ten samples were collected they were taken immediately to the laboratory and plated. Whereas, only bacteria count was desired, the Tryptone-Glucose Extract Agar[1]

[1] "Standard Methods of Milk Analysis," American Public Health Association, Seventh edition, 1939.

TABLE I

CONDITION OF MILK ON FARM AND READY FOR THE HAULER

Producer	Sample	Time*	Temp.	Bacteria (c.c.)
1	a	14	62	150 000
	b	2	90	17 000
	c	13	70	180 000
	d	1	85	20 000
	e	13	66	700 000
	f	1	90	20 000
	g	13	64	680 000
	h	1.5	87	25 000
	i	12	68	900 000
	j	1	90	16 000
2	a	14	64	900 000
	b	1	90	140 000
	c	13	70	1 000 000
	d	1	92	200 000
	e	12	68	900 000
	f	1	90	85 000
	g	12	62	350 000
	h	1.5	82	70 000
	i	12	74	1 100 000
	j	1	90	102 000
3	a	13	66	10 000 000
	b	1	92	430 000
	c	12	68	20 000 000
	d	1	92	310 000
	e	12	68	30 000 000
	f	1	90	300 000
	g	12	66	32 000 000
	h	1.5	84	200 000
	i	12	72	18 000 000
	j	1	90	250 000
4	a	13	40	90 000
	b	1	50	47 000
	c	11	42	64 000
	d	1.5	55	50 000
	e	12	42	80 000
	f	1	90	30 000
	g	12	42	33 000
	h	1	92	37 000
	i	12	50	96 000
	j	1	92	35 000

TABLE I (Continued)

Producer	Sample	Time*	Temp.	Bacteria (c.c.)
5	a	12	72	920 000
	b	1	92	87 000
	c	13	68	860 000
	d	1	91	80 000
	e	13	62	800 000
	f	1	93	122 000
	g	13	66	1 000 000
	h	1	92	92 000
	i	13	68	1 100 000
	j	1	92	100 000
6	a	13	40	240 000
	b	1	92	34 000
	c	13	41	420 000
	d	1	93	72 000
	e	13	40	590 000
	f	1.5	65	71 000
	g	13	40	540 000
	h	1.5	90	100 000
	i	13	40	480 000
	j	1	91	72 000
7	a	12	38	42 000
	b	1	92	12 000
	c	13	38	56 000
	d	1.5	50	34 000
	e	14	38	31 000
	f	2	41	11 000
	g	14	38	30 000
	h	2	46	12 000
	i	14	38	28 000
	j	2	40	15 000
8	a	13	66	160 000
	b	1	90	8 000
	c	13	68	50 000
	d	1	92	7 000
	e	12	60	200 000
	f	1	91	1 000
	g	12	64	400 000
	h	1	94	2 500
	i	13	64	390 000
	j	1	93	3 000

TABLE I (Continued)

Producer	Sample	Time*	Temp.	Bacteria (c.c.)
9	a	12	60	500 000
	b	1	90	3 000
	c	12	62	300 000
	d	1.5	86	4 000
	e	12	65	110 000
	f	1	93	100 000
	g	12	65	300 000
	h	1.5	96	39 000
	i	12	65	300 000
	j	1	92	29 000
10	a	12	64	300 000
	b	1	92	5 000
	c	12	62	200 000
	d	1	92	100 000
	e	13	68	2 300 000
	f	1	92	8 000
	g	11	67	400 000
	h	1	93	4 000
	i	13	62	500 000
	j	1.5	76	5 000

* Time indicates the number of hours elapsing from time milk was drawn until sample was taken. Morning milk and previous night's milk are hauled on same trip.

media was prepared. This formula consisted of:

Beef extract	3 g.
Tryptone	5 g.
Dextrose (d-glucose)	1 g.
Agar	15 g.

To this mixture one thousand grams of water was added; then the mixture was heated until contents were dissolved. The prepared hot media was then titrated into test tubes and plugged with cotton.

Before use, the agar media was sterilized by exposure for twenty-five minutes to fifteen pounds steam pressure in the autoclave. All other glassware was sterilized by subjecting it to two hours' dry heat at one hundred ninety degrees Centigrade. To dilute the milk for counting, one cubic centimeter of milk was added to ninety-nine cubic centimeters of sterile water. Where a count of not more than one hundred thousand bacteria per cubic centimeter was expected, one-tenth cubic centimeter of this solution was plated. If a count above one hundred thousand was anticipated, the dilution ratio was one to one hundred thousand with a lower dilution used as a check.

The closed truck, which was first to arrive at the plant, was met and a sample was taken from the can of Producer Numbers one and two. The temperature and time of arrival were also noted. In this manner the data for condition of milk both at the farm and at the plant were obtained for compilation

as Table I and Table II. However, in Table II the sample analyzed was obtained by mixing one-half a sample of night's milk and one-half a sample of morning's milk.[2] At this visit a specimen of milk was collected from the large temporary holding vats. All were taken immediately to the laboratory and plated. Approximately one and one-half hours later the open truck arrived and the samples of Producer Numbers three and four were taken. This procedure was then used for five days with the next four producers and their milk samples both at the farm and at the plant. Daily checks were made on the milk immediately after pasteurizing and also on milk bought at random at retail stores. The findings of these checks are reported in Table III.

Table IV is a summary of temperature, delivery time, and bacteria count of each producer's milk. It was not, in most instances, feasible to obtain the temperature at which the morning milk was placed on the truck; so the holding temperature of night's milk was used in column two. Likewise, in order to compare honestly, the temperature of the night's milk only was taken at the plant. It is listed in column four. Time column indicates the duration from morning milking, when the milk is ready for market, until its arrival at the

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[2]Milk analysis samples taken by distributors are composite samples.

TABLE II

SAME MILK AS IN TABLE I UPON ARRIVAL AT RECEIVING PLANT

Producer	Sample	Time*	Temp.	Bacteria (c.c.)
1	a	6	72	350 000
	b	5	70	600 000
	c	6	72	460 000
	d	5.5	70	500 000
	e	5.5	76	550 000
2	a	6	72	1 200 000
	b	5	73	900 000
	c	5.5	70	1 300 000
	d	6	69	1 200 000
	e	5.5	74	980 000
3	a	6	86	54 000 000
	b	8	85	32 000 000
	c	7.5	79	T.N.C.**
	d	8	81	T.N.C.
	e	7	79	43 800 000
4	a	8	72	750 000
	b	8	65	800 000
	c	7	67	980 000
	d	7	70	760 000
	e	6.5	68	1 600 000
5	A	6.5	76	1 020 000
	b	6	75	2 300 000
	c	6.5	70	3 000 000
	d	6	74	3 200 000
	e	6	72	3 100 000

** Too numerous to count.

TABLE II (Continued)

Producer	Sample	Time*	Temp.	Bacteria (c.c.)
6	a	6	48	810 000
	b	5	51	1 080 000
	c	6.5	53	960 000
	d	6	57	1 190 000
	e	6	59	950 000
7	a	6	43	62 000
	b	6.5	42	53 000
	c	6	43	36 000
	d	6	44	48 000
	e	6.5	43	43 000
8	a	5	70	130 000
	b	5.5	72	160 000
	c	5	66	200 000
	d	5	69	190 000
	e	5	68	360 000
9	a	6	62	530 000
	b	6	68	1 750 000
	c	6	70	685 000
	d	5.5	67	1 450 000
	e	5.5	72	1 250 000
10	a	8	76	6 550 000
	b	7	77	6 050 000
	c	7.5	76	6 400 000
	d	7	75	2 300 000
	e	6	74	4 400 000

* Time indicates lapse between morning milking and arrival at the plant.

TABLE III

REPRESENTATIVE SAMPLES OF MILK IN THREE STAGES OF PROCESSING AND DISTRIBUTION

No.	Holding Vat	At Bottler	Retail Outlet
1	3 200 000	110 000	150 000
2	3 000 000	105 000	97 000
3	3 500 000	101 000	260 000
4	3 250 000	120 000	39 000
5	6 000 000	71 000	98 000
6	3 500 000	53 000	118 000
7	8 000 000	74 000	290 000
8	8 500 000	96 000	162 000
9	10 000 000	118 000	96 000
10	8 000 000	105 000	109 000
11	9 000 000	108 000	194 000
12	7 000 000	110 000	143 000
13	3 500 000	76 000	101 000
14	3 000 000	73 000	98 000
15	4 000 000	70 000	90 000
16	4 500 000	72 000	105 000
17	11 500 000	125 000	442 000
18	8 000 000	92 000	200 000
19	8 000 000	90 000	100 000
20	9 500 000	102 000	96 000
21	4 000 000	52 000	62 000
22	3 700 000	54 000	120 000
23	7 000 000	91 000	104 000
24	5 200 000	73 000	93 000
25	10 200 000	111 000	250 000

TABLE III (Continued)

No.	Holding Vat	At Bottler	Retail Outlet
26	9 800 000	76 000	160 000
27	8 000 000	92 000	130 000
28	9 900 000	100 000	184 000
29	11 400 000	117 000	220 000
30	8 200 000	110 000	110 000
31	9 000 000	104 000	130 000
32	9 400 000	98 000	100 000
33	6 000 000	50 000	99 000
34	7 200 000	84 000	110 000
35	8 000 000	72 000	74 000
36	7 000 000	98 000	190 000
37	7 600 000	83 000	100 000
38	8 000 000	88 000	164 000
39	7 000 000	81 000	200 000
40	7 200 000	79 000	170 000
41	8 100 000	6 000	200 000
42	10 000 000	32 000	100 000
43	9 400 000	6 000	130 000
44	6 000 000	27 000	48 000
45	5 700 000	25 000	52 000
46	5 000 000	32 000	98 000
47	11 000 000	17 000	47 000
48	9 400 000	8 000	116 000
49	16 000 000	38 000	31 000
50	17 000 000	17 000	52 000

TABLE IV

AVERAGE TEMPERATURE, TIME, AND BACTERIA COUNT IN HANDLING FARMER'S MILK

Producer	Aver. Temp. at farm	Aver. Delivery Time	Aver. Temp. at Plant	Bacteria Count (per c.c.) Night	Morning	Plant*
1	65	5.6	72	522000	19800	492000
2	67.6	5.6	71.6	1480000	119400	1116000
3	68	7.3	82	22000000	298000	49660000
4	43.2	7.3	68.4	72600	39800	978000
5	67.2	6.2	73.4	936000	96600	2524000
6	40.2	5.9	53.6	454000	69800	998000
7	38	6.2	43	37400	16800	48400
8	64.4	5.1	69	240000	4300	208000
9	63.4	5.8	67.8	302000	35000	1113000
10	64.6	7.1	75.6	740000	24400	5140000

* Bacteria Count at Plant is Average of Night and Morning Milk when it arrives at the Plant.

distributing plant. This period added to the period that the farmer holds his previous night's milk should point out a serious fault in the marketing system. As previously noted, the sample for bacteria analysis was a composite of night and morning milk.

The extreme variation in bacteria content of the various samples made a graphic presentation of actual values impossible. Figure V shows the interpretation by means of a bar graph of the logarithmic values of the median counts at various stages in milk handling. The actual median values which this graph depicts are found in Table VI. An examination of Figure V and Table VI will bring out in vivid profile the faulty handling, not only in the milking process, but also in the delay and temperature increases as the precious food was sent on its way from its source to the consumer.

In order to present a complete picture of the handling methods, a measure of the hauling factor was taken. Table VII presents data showing the length of time the farmer's milk was kept on the trucks and the amount of temperature increase during this costly delay. No attempt was made to check the position of the various cans on the trucks (such as their being near warmer milk or in the direct sunlight) or other factors which obviously would influence temperature change. It was noted, however, that on the closed truck warm milk ap-

TABLE V

LOGARITHMIC VALUES (BASE 10) OF MEDIANS OF BACTERIA COUNTS AT VARIOUS STAGES IN MILK HANDLING (SEE TABLE VI)

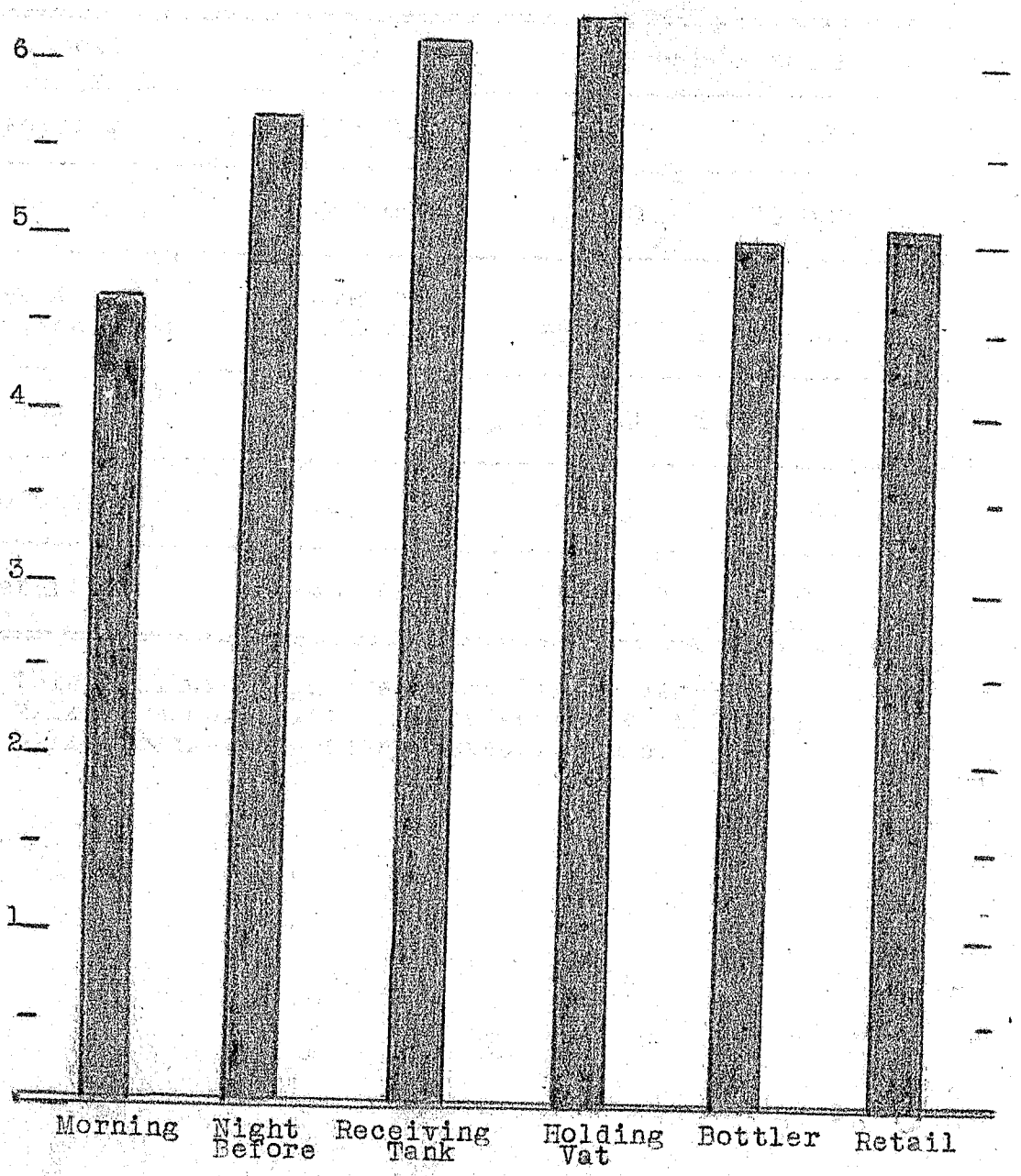

TABLE VI

QUANTITATIVE ANALYSIS (PLATE COUNT) OF MILK AT VARIOUS STAGES IN HANDLING

Production Stage	High	Low	Median
Morning	298 000	4 300	37 000
Night Before*	22 000 000	37 400	488 000
Receiving Tank	over ** 50 000 000	43 000	1 056 000
Holding Vat	17 000 000	3 000 000	8 000 000
Bottler ***	125 000	6 000	82 000
Retail	442 000	31 000	103 000

* This milk was held overnight before sample was taken.
** Milk of such quality was rejected by distributor.
*** Milk immediately after pasteurization.

TABLE VII

COMPARATIVE ANALYSIS OF TIME AND TEMPERATURE ON OPEN AND CLOSED TRUCKS

Farmer Patron	Closed Truck		Open Truck	
	Hours on Road	Temp. Increase	Hours on Road	Temp. Increase
Producer #1	5	7		
Producer #2	5.5	4		
Producer #3			6	14
Producer #4			6	25.2
Producer #5			1	6.2
Producer #6			1	13.6
Producer #7	.5	5		
Producer #8	.5	4.6		
Producer #9	5	4.4		
Producer #10			7	11
Daily Average	3.3	5	4.2	13.9
Average Temperature Increase per Hour on Road		1.5		3.25

preciably decreased in temperature at the expense of the cooler milk. Also, the difference in hauling time necessitated the computation of the increase in temperature per hour on the road; but, since delay, as well as type of truck, is a factor, it was necessary to present the overall increase per can of milk.

CHAPTER III

CONCLUSIONS AND RECOMMENDATIONS

A careful weighing of the factors in milk handling and quality of product will reveal some very tenable conclusions. Quality-milk programs invariably stress dairy-farm facilities as a major factor in the production of good milk. Data collected in this study indicate facilities have a low correlation with bacteria count. In Table IV, referring to Producers 1, 4, 6, and 7, who were using facilities approaching state approved standards, it will be seen that there was great variation in morning milk counts, and, also, that all were considerably higher than Number 8 who had no approved equipment. In all cases except Number 1 the milk arrived at the plant at a temperature below 70 degrees.

While it can not be said that closed and insulated shipping beds will insure quality milk, smaller temperature increase per hour in transit as indicated in Table VII does make for better milk. It is a very remote possibility that any water-cooled milk can be shipped by way of open truck and arrive at the plant with a temperature below 70 degrees. Also it will be noted that the high plant count of Number 4 in Table IV excludes his milk from Grade "A" classification even though it left the farm with a very low temperature and a favorable count.

Contrasting the plant counts of Number 4 and Number 7, (Table IV) indicates that milk left in the care of the farmer was of much better quality than that which spent many hours in transit.

The high bacteria count and resultant deterioration of the milk in the holding vats would support the conclusion that the distributor is attempting to reconstitute a very low grade of milk. Chemical agents foreign to fresh milk must be added to it to make it saleable as whole milk.

Approximately ninety-nine per cent killing rate through pasteurization tends to show that the distributor is doing a good job of controlling bacteria after the milk comes under his processes.

Milk, as the consumer buys it, has lost its identity as the pure whole product that left the udder of the cow. Careless handling on the part of the retailers further lowers the palatability of milk.

If fast delivery from farm to market had been provided, eighty per cent of the milk tested could have been processed and sold as a high quality unadulterated food. As shown in the morning column of Table IV, eight of the ten producers had milk with bacteria counts less than one hundred thousand per cubic centimeter. At the plant, however, nine of ten milk samples were too high in bacteria to meet Grade "A" specifica-

tions. That is not the farmer's shortcoming.

Milk is, perhaps, the only commodity sold on an ungraded basis. Producer Number 7 receives the same rate of pay for his milk and pays the same hauling rate as Number 3. Although some markets do establish a differential for milk meeting government standards of grading, more emphasis is placed upon facilities than upon the milk itself. Incentive of a financial nature must be offered to induce quality production.

Inasmuch as there is a great variation in individual farmers' milk quality, a distributor should not attempt to pool all the incoming milk. That which is intended for the bottle should be selected at the receiving room.

It was very evident to this investigator that some producers had excellent methods for producing milk, while others were very negligent, or, perhaps, ignorant. It would seem that a program of production supervision and education would yield splendid returns in providing the processor with a product superior to that which he is now receiving. However, production on the farm is not the only process that needs attention. Really good milk can not be placed on the retail market in great quantity until there is a complete overhauling of the raw-milk marketing system. This overhauling will have to take radical form. The aim will be greatly to shorten the time consumed in getting the milk from the udder

to the retail bottle. It is time to give attention to fundamentals. Applied to milk they are: time, temperature, and contamination.

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