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MILK QUALITY AS DETERMINED BY PRESENT DAIRY
SCORE CARDS.

JAMES D. BREW.



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* On leave of absence. † Connected with the Chautauqua Grape Work. ** Connected with Hop Culture Investigations.

MILK QUALITY AS DETERMINED BY PRESENT DAIRY SCORE CARDS.

JAMES D. BREW.

SUMMARY.

1. Dairy score cards were originally designed to instruct the dairyman and to serve as a convenient record of sanitary conditions. Their use has led to a common belief that there is a relation between the score of the dairy and the quality of the milk produced by it. Scores are even being used as the sole basis for the grading of milk according to quality.

2. The investigation reported in this bulletin was a comparative study between the bacterial content of the milk and the scores of 34 commercial dairies made on three representative cards, namely, the Cornell card, the Official card approved by the Official Dairy Instructors' Association and the New York City card. The purpose was to determine what relationship existed between the bacteria count and the score; and how different cards agreed when the same conditions were scored simultaneously by one person.

3. The results of the investigation show no correlation whatever between the quality of the milk so far as it could be determined by laboratory methods and the score as expressed by any one of these three cards.

4. Using officially accepted interpretations of each of the three score cards, it was found that there was some variation in the relative positions of the various dairies when scored simultaneously with all of the cards. In general, however, the scores secured by using the Cornell card were the most lenient, while those secured by using the New York City card were the most severe. None of the 34 dairies scored below the exclusion point on either the Cornell or Official card, while 15 dairies scored below this point on the New York City card.

INTRODUCTION.

The grading of milk according to quality, as is being done with many articles of food, is now considered essential as a means of improving city milk supplies. The earlier attempts to control milk quality were largely based upon chemical tests. The purpose

of this control was to guard the public against fraud, practiced by altering the normal constituents of the milk or adding preservatives to it. Recently, however, attention has been more concerned with the qualities of milk as affected by the presence of bacteria.

Two general types of bacteria are of interest in this connection, namely, those which do not cause disease and those which do cause disease. The first are important because large numbers of them in milk indicate that it is no longer fresh; the second, because their presence involves danger to health. The lack of satisfactory laboratory technique for the detection of the latter kinds of bacteria has caused attention to be directed largely towards keeping the total number of bacteria at a minimum in all market milk.

Early in the development of sanitary milk work, it became evident that the conditions under which the milk was produced on the farm played a large part in determining the amount of bacterial contamination. Consequently it was reasoned that the improvement of barn construction and of dairy methods would insure a safe, pure milk. As a result, all of the various factors supposed to affect milk production were incorporated in dairy score cards, the use of which appeared to be the most practical means of obtaining the desired improvement. These cards have now come into general use both by health officials and by commercial dairy companies. The various conditions or methods considered essential were allotted certain numerical ratings on these score cards, the importance and value of which were determined as well as could be done in the light of the knowledge then available.

The aim in designing the score card was to instruct the producer in the importance of cleanliness in handling milk and to designate those places where improvement could be made. At the same time the card served as a record of the sanitary conditions. There was no thought of the score being used as an index of the quality of milk produced. Of late, however, with the increasing movement in favor of grading milk according to actual quality, the score card has been drawn into use as a convenient means of determining grades of milk. This implies that there is a relationship between the quality of milk and the dairy score. Moreover, there appears to be a widespread belief that such a relationship exists.

For this reason the present investigation was undertaken to determine whether there is a correspondence between the actual

quality of milk produced and the dairy score. Furthermore, since there are several such cards in use, a study has also been made to determine whether the scores secured by the use of different cards agree when the same conditions are scored on each simultaneously.

WHAT IS MEANT BY MILK QUALITY.

Before proceeding further, it is necessary to make clear what is understood when speaking of milk quality. This is not easy to define because opinions differ widely and several variable factors must be taken into consideration. For the purpose of discussion, the following definition will be used: Milk to be of high quality should (1) have a food value suited to the needs of the consumer, (2) should be free from visible dirt, unpleasant odors and tastes, (3) should not contain an excessive number of bacteria and (4) should be free from disease germs.

The difficulties which beset an investigation which attempts to compare the actual quality of milk with barn scores are at once apparent. In the first place, the actual quality of milk as defined above is difficult to determine by means of present laboratory methods. There is no way of accurately measuring such factors as odors, tastes and dirt in milk, nor (from the standpoint of routine analysis) is there any practical means of detecting the presence of disease organisms. In the second place, the chemical constituents of the milk are not mentioned on dairy score cards. This leaves only one means by which the quality of milk and the dairy score may be compared, namely, the bacteria count.

THE INVESTIGATION.

PLAN OF WORK.

For several years this Station has been investigating the relative importance of the various dairy operations or conditions specified on the score card from the sanitary standpoint. The work was originally planned by Dr. H. A. Harding, and is now being carried on in cooperation with the Illinois Agricultural Experiment Station. In this connection a comparative study of score cards was made. The purpose of this was, primarily, to determine the agreement

between the final scores when the same dairy conditions were scored at the same inspection on different score cards. Many forms of cards have been devised; but it was impossible and unnecessary to make use of all in existence. Consequently three cards were selected which were unquestionably representative.

The first card chosen is the one known as the Official Score Card, because of its endorsement by the Official Dairy Instructors' Association. This has now become of greater importance in this State because of its adoption with slight modification as the official card for New York State by the State Board of Health. The second is the one in use by the New York City Board of Health; and the third was the one then in use by the Dairy Department of the Agricultural College at Cornell University. The three cards are reproduced on pages 111, 112-3 and 114 respectively.

In order to conduct such a comparative study it was essential that someone become thoroughly familiar with each card and the manner of its application. This was undertaken by the author, who had already become acquainted with the Cornell card while acting as dairy inspector for the Ithaca Board of Health. To become acquainted with the other two cards necessitated spending some time with inspectors familiar with the cards in question. Nearly three weeks were spent working with inspectors for the New York City Board of Health. One week was spent with an inspector representing the Dairy Division of the Bureau of Animal Industry of the U. S. Department of Agriculture.

It must be recognized that the interpretation of the different cards is an important and varying factor. Two inspectors, working independently, do not score the same conditions exactly alike on the same card; and even the same inspector cannot score the same conditions alike at different times. In the preliminary study the aim was to learn the general interpretation of each card from persons familiar with its use and then to apply all three cards simultaneously to the same conditions with the personal element controlled by having the scoring done by one person. Every scoring was made very carefully, giving each card as nearly as possible the interpretation officially accepted, regardless of any personal opinions held by the scorer.

The interpretations of the cards given on pages 116 and 117 were found to be in use by the inspectors.

OFFICIAL SCORE CARD.

United States Department of Agriculture, Bureau of Animal Industry.

Dairy Division.

Indorsed by the Official Dairy Instructors' Association.

EQUIPMENT.	SCORE.		METHODS.	SCORE.	
	Perfect.	Allowed.		Perfect.	Allowed.
COWS.			COWS.		
Health.....	6	-----	Cleanliness of cows.....	8	-----
Apparently in good health..... 1			(Free from coarse dirt, &c.)		
If tested with tuberculin within			STABLES.		
a year and no tuberculosis is			Cleanliness of stables.....	6	-----
found, or if tested within six			Floor..... 2		
months and all reacting ani-			Walls..... 1		
mals removed..... 5			Ceiling and ledges..... 1		
(If tested within a year and react-			Mangers and partitions..... 1		
ing animals are found and removed,			Windows..... 1		
2.)			Stable air at milking time.....	6	-----
Food (clean and wholesome).....	2	-----	Freedom from dust..... 3		
Water.....	2	-----	Freedom from odors..... 2		
Clean and fresh..... 1			Cleanliness of bedding..... 1		
Convenient and abundant..... 1			Barnyard.	2	-----
STABLES.			Clean..... 1		
Location of stable.....	2	-----	Well drained..... 1		
Well drained..... 1			Removal of manure daily to field or		
Free from contaminating sur-			proper pit..... 2		
roundings..... 1			(To 60 feet from stable, 1.)		
Construction of stable.....	4	-----	MILK ROOM OR MILK HOUSE.		
Tight, sound floor and proper			Cleanliness of milk room.....	3	-----
gutter..... 2			UTENSILS AND MILKING.		
Smooth, tight walls and ceiling... 1			Care and cleanliness of utensils.....	8	-----
Proper stall, tie, and manger..... 1			Thoroughly washed..... 2		
Provision for light: Four sq. ft. of			Sterilized in live steam for 15		
glass per cow..... 4			minutes..... 3		
(Three sq. ft. 2; 2 sq. ft. 2; 1 sq.			(Placed over steam jet, or scalded		
ft. 1. Deduct for uneven distribu-			with boiling water, 2.)		
tion.)			Inverted in pure air..... 3		
Bedding.....	1	-----	Cleanliness of milking.....	9	-----
Ventilation.....	7	-----	Clean, dry hands..... 3		
Provision for fresh air, control-			Udders washed and dried..... 6		
lable due system..... 3			(Udders cleaned with moist cloth,		
(Windows linged at bottom,			4; cleaned with dry cloth or brush		
1.50; sliding windows, 1;			at least 15 minutes before milking,		
other openings, 0.50.)			1.)		
Cubic feet of space per cow, 500			HANDLING THE MILK.		
ft. (Less than 500 ft. 2; less than			Cleanliness of attendants in milk		
400 ft. 1; less than 300 ft. 0.)			room..... 2		
Provision for controlling tempera-			Milk removed immediately from		
ture..... 1			stable without pouring from pail..... 2		
UTENSILS.			Cooled immediately after milking		
Construction and condition of uten-			each cow..... 2		
sils..... 1			Cooled below 50° F..... 5		
Water for cleaning.....	1	-----	(51° to 55°, 4; 56° to 60°, 2.)		
(Clean, convenient, and abundant.)			Stored below 50° F..... 3		
Small-top milking pail.....	3	-----	(51° to 55°, 2; 56° to 60°, 1.)		
Facilities for steam.....	1	-----	(If delivered twice a day, allow		
(Hot water, 0.50.)			perfect score.)		
(In milk house, not in kitchen.)			Transportation below 50° F..... 2		
Milk cooler.....	1	-----	(51° to 55°, 1.50; 56° to 60°, 1.)		
Clean milking suits.....	1	-----	MILK ROOM OR MILK HOUSE.		
MILK ROOM OR MILK HOUSE.			Location: free from contaminating		
Construction of milk room.....	2	-----	surroundings..... 1		
Floor, walls, and ceiling..... 1			Construction of milk room.....		
Light, ventilation, screens..... 1			Floor, walls, and ceiling..... 1		
Separated rooms for washing utensils			Light, ventilation, screens..... 1		
and handling milk..... 1			Separated rooms for washing utensils		
Total.....	40	-----	and handling milk..... 1		
			Total.....	60	-----

Equipment + Methods = Final Score.

NOTE 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

NOTE 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

ORIGINAL.

Equipment	40%	Score.....%
Methods	60%	Score.....%
Perfect Dairy	100%	Score.....%

DEPARTMENT OF HEALTH.

THE CITY OF NEW YORK.

Division of Milk Inspection.

Dairy Report.

Inspection No. Time A. P. M. Date 191

1 Dairyman Owner

2 P. O. Address P. O. Address State

3 County State Party Interviewed

4 Milk delivered to Creamery at Formerly at

5 Operated by Address

6 Distance of farm from Creamery Occupied farm since

7 No. Cows No. Milking No. Qts. Produced

8 All persons in the households of those engaged in producing or handling milk are
free from all infectious disease. Weekly reports are being filed

9 Date and nature of last case on farm

10 WATER SUPPLY for utensils is from a located feet deep
and apparently is pure and wholesome

State any possible contamination located within 200 feet of source of water supply or if water
supply is not protected against surface drainage

11 Water supply on this farm analyzed 191 Result

12 Style of Cow Barn Length ft. Width ft. Height of ceiling ft.

13 Dairy Rules of the Department of Health are posted

14 Dairy Herd examined by on 191 Report

	Perfect.	Allow.
EQUIPMENT		
15 COW STABLE is located on elevated ground with no stagnant water, hog-pen, privy, uncovered cesspool or manure pit within 100 feet....	1	.....
16 FLOORS, other than cow beds, are of concrete or some non-absorbent material	2	.....
17 Floors are properly graded and water-tight	2	.....
18 Cow beds are of concrete or planks laid on concrete	2	.....
19 DROPS are constructed of concrete, stone or some non-absorbent material	2	.....
20 Drops are water-tight and space beneath is clean and dry	2	.....
21 CEILING is constructed of and is tight and dust proof	2	.....
22 WINDOWS No. total square feet. there is 2 square feet of window light for each 600 cu. ft. air space (1 sq. ft. per each 600 cu. ft.—1)	2	.....
23 VENTILATION consists of sq. ft. muslin covered openings or sq. ft. open chutes in ceiling or which is sufficient 3, fair 2, poor 1, insufficient 0	3	.....
24 AIR SPACE is cu. ft. per cow (600 and over—3) (500 to 600—2) (400 to 500—1) (under 400—0)	3	.....
25 LIVE STOCK, other than cows, are excluded from rooms in which milk cows are kept	2	.....
26 There is direct opening from stable into silo or grain pit	1	.....
27 Separate quarters are provided for cows when calving or sick	1	.....
28 COW YARD is properly graded and drained	2	.....
29 WATER SUPPLY for cows is unpolluted and plentiful	1	.....

	Perfect.	Allow.
30 MILK HOUSE has.....direct opening into cow barn or other building..	1	.....
31 Milk house has.....sufficient light and ventilation.....	1	.....
32 Floor is.....properly graded and water-tight.....	1	.....
33 Milk house is.....properly screened to exclude flies.....	1	.....
34 Milk pails are.....of smoothly tinned metal in good repair.....	1	.....
35 MILK PAILS have.....all seams soldered flush.....	2	.....
36 Milk pails are.....of the small-mouthed design, top opening not exceed- ing 8 inches in diameter. Diameter.....	2	.....
37 Racks are.....provided to hold milk pails and cans when not in use....	2	.....
38 Special milking suits are.....provided.....	1	.....
40		.....
METHODS		
39 STABLE INTERIOR painted or whitewashed on.....which is satis- factory 3, fair 2, unsatisfactory 1, never 0.....	3	.....
40 FEEDING TROUGHS, platforms or cribs are.....well lighted and clean	1	.....
41 Ceiling is.....free from hanging straw, dirt or cobwebs.....	3	.....
42 Window panes are.....washed and kept clean.....	1	.....
43 WALLS AND LEDGES are.....free from dirt, dust, manure or cobwebs.....	2	.....
44 FLOORS AND PREMISES are.....free from dirt, rubbish or decayed animal or vegetable matter.....	2	.....
45 COW BEDS are.....clean, dry and no horse manure used thereon.....	2	.....
46 Manure is.....removed to field daily 4, to at least 100 feet from barn 2, stored less than 100 feet or where cows can get at it 0.....	4	.....
47 Liquid matter is.....allowed to saturate ground under or around cow barn	2	.....
48 Milking stools are.....clean.....	1	.....
49 Cow Yard is.....clean and free from manure.....	2	.....
50 COWS have.....been tuberculin tested and all tuberculous cows removed	7	.....
51 Cows are.....all in good flesh and condition at time of inspection.....	2	.....
52 Cows are.....all free from clinging manure and dirt. (No dirty.....)	4	.....
53 LONG HAIRS are.....kept short on belly, flanks, udder and tail.....	1	.....
54 UDDER AND TEATS of cows are.....thoroughly brushed and wiped with a clean damp cloth before milking.....	3	.....
55 ALL FEED is.....of good quality and distillery waste or any substance in a state of putrefaction is.....fed.....	2	.....
56 MILKING is.....done with dry hands.....	2	.....
57 FORE MILK or first few streams from each teat is.....discarded.....	2	.....
58 Clothing of milkers is.....clean.....	1	.....
59 Facilities for washing hands of milkers are.....provided in cow barn or milk house.....	2	.....
60 Milk is strained at.....and.....in clean atmosphere.....	1	.....
61 Milk is.....cooled within two hours after milking to 50 degrees F. 3, to 55 degrees F. 2, to 60 degrees F. 1.....	3	.....
62 Ice is.....used for cooling milk.....	1	.....
63 MILK HOUSE is.....free from dirt, rubbish and all material not used in the handling and storage of milk.....	1	.....
64 Milk utensils are.....rinsed with cold water immediately after using and washed clean with hot water and washing solution.....	2	.....
65 Utensils are.....sterilized by steam or boiling water after each using.....	2	.....
66 Privy is.....in sanitary condition, with vault and seats.....covered and protected.....	1	.....
60		.....

Remarks.....

.....
Duplicate Score Received

.....
Dairyman.

.....
Inspector of Foods.

Cornell Score Card for Production of Sanitary Milk.

Date..... Dairy of..... P. O.....

Retailed by.....

		Perfect Score.	Cuts.
I. HEALTH OF THE HERD AND ITS PROTECTION.	Health and comfort of the cows and their isolation when sick or at calving time.	45	.....
	Location, lighting and ventilation of the stable.	35	.....
	Food and water.	20	.....
	Total	100	.....
II. CLEANLINESS OF THE COWS AND THEIR SURROUNDINGS.	Cows	30	.....
	Stable	20	.....
	Barnyard and pasture	20	.....
	Stable air (freedom from dust and odors) ..	30	.....
	Total	100	.....
III. CONSTRUCTION AND CARE OF UTENSILS.	Construction of utensils and their cleaning and sterilizing.....	40	.....
	Water supply for cleaning and location and protection of its source	25	.....
	Care of utensils after cleaning	20	.....
	Use of small-top milking pail.....	15	.....
	Total	100	.....
IV. HEALTH OF EMPLOYEES AND MANNER OF MILKING.	Health of employees	45	.....
	Clean over-all milking suits and milking with clean, dry hands	30	.....
	Quiet milking, attention to cleanliness of the udder and discarding the foremilk ..	25	.....
	Total	100	.....
V. HANDLING THE MILK.	Prompt and efficient cooling	35	.....
	Handling milk in a sanitary room and holding it at a low temperature	35	.....
	Protection during transportation to market ..	30	.....
	Total	100	.....
	TOTAL OF ALL SCORES.....	500	

If the total of all scores is	And each division is	The sanitary conditions are
480 or above.....	90 or above.....	EXCELLENT
450 or above.....	80 or above.....	GOOD
400 or above.....	60 or above.....	MEDIUM
Below 400.....	Or any division is below 60.....	POOR

The sanitary conditions are..... Scored by.....

SCORE CARD CUTS USED ON CORNELL CARD.*

HEALTH OF HERD AND ITS PROTECTION.

- No tuberculin test, 12.
- Old tuberculin test (over one year), 12.
- Rigid stanchions (not cut when cows were confined only during milking, as in summer), 3.
- Light, 1 to 5, according to conditions.
- No special system of ventilation, 2.
- Ventilation 1 to 5.
- No comfortable provision for isolation or calving outside of stable containing milking cows, 5.
- Stable poorly built to protect from the weather, 1 to 5.

CLEANLINESS OF COWS AND THEIR SURROUNDINGS

- Manure or dust on cows, 1 to 10.
- Hair about udders not clipped, 1.
- Damp cloth not used on udders before milking, 2.
- Litter or roughage on stable floor, 1 to 5.
- Ceiling not tight, 1 to 5.
- Cobwebs and dust in stable, 1 to 5.
- Stable not whitewashed within one year, 5.
- Horse in cow stable, 5.
- Manure not removed once per day, 1 to 10.
- Manure or mud in barnyard to which cows have access, 1 to 10.
- Feeding dry feed just before milking, 1 to 10.
- Objectionable odors in stable, 1 to 5.

CONSTRUCTION AND CARE OF UTENSILS

- Insufficient cleaning, 1 to 5.
- No special sterilization (no steam), 5.
- No small-topped pail, 15.

HEALTH OF EMPLOYEES AND MANNER OF MILKING

- No special clean milking suits, 5.
- Dirty suits, 1 to 5.
- Milking with wet hands, 10.
- Unclean hands, 1 to 6.

HANDLING THE MILK.

- Not efficiently cooled (50° F. or below).
 - 50° to 60°, cut 5.
 - 61° to 70°, 10.
 - above 71°, 15.
- Not held at 50° F. or below, 5.
- Milk strained in stable, 5.
- Milk room not clean, 1 to 5.
- No milk room, 3.

* These were the cuts as applied to actual conditions. More unsanitary surroundings would merit greater cuts than those indicated.

New York City card.—In rating the various requirements on this card, full credit was allowed any condition or method which was considered perfect, but if imperfect in any way it was given zero. No attempt was made to divide any of the points according to actual conditions, except as specified on the card itself.

Official card.—Each individual requirement on this card was allowed due credit according to its actual condition or degree of compliance, so far as possible. In other words, the aim was to recognize even slight changes in sanitary conditions since the previous inspection. All ratings were made upon a percentage basis, determined by the judgment of the inspector. Take, for instance, the question of the cleanliness of the ceiling which was scored 1 point by the inspector if perfect. If the ceiling was not clean the inspector would take into account the cobwebs, straws, etc., and might conclude that the ceiling was 25 per ct. dirty. He would then deduct 25 per ct. from 100 per ct. and write the score down as .75. Strictly speaking this method of deduction is equivalent to scoring on the basis of 10,000 and therefore requires an impossible mathematical accuracy, especially when dealing with such intangible and unmeasurable factors as are found on all dairy score cards. Exceptions were made in a few instances where the cuts were specified, and in a few others such as "Food" and "Water" where full credit was allowed in all ordinary cases.

Cornell card.—The system of cuts used with this card was flexible, although fairly well standardized (see page 115).

In actual practice it is possible to subject any of the cards to widely different interpretations. In fact, one instance is known where the Official card is interpreted in a way quite similar to that described under the New York City card. The three cards were used in this investigation according to the interpretations just described.

An examination of the cards reveals the fact that each is made out on a somewhat different basis; although there is a marked similarity between the Official and New York City cards. On both, a perfect score is rated 100 per ct. of which 40 per ct. is allowed for equipment and 60 per ct. for methods. These two cards, however, differ considerably in treatment of various barn conditions or methods. For instance the New York City card places much emphasis upon the necessity of a concrete or other non-absorbent

floor (10 points in all) while the Official card simply requires a tight, sound floor with proper gutter (2 points in all) and makes no reference to the material used for construction. There are several other instances where differences occur, one of the most important of which is that the Official card devotes 16 points to the handling of the milk immediately after it is drawn from the cow while the New York City card devotes but 5 points to the same thing.

The numerical basis of the Cornell card is entirely different from that of the other two cards. Dairy operations or conditions are classified under five headings with a perfect score of 100 for each, making a total score of 500. The barns are then classed as "Excellent," "Good," "Medium" or "Poor," according to their score.

Since this work was completed the following changes have been made in the Official card. The item "Food (clean and wholesome)" has been reduced from 2 points to 1 point for a perfect score. The item with reference to water has been changed to read "Water (clean and fresh)" allowing 1 point in place of 2, for a perfect score. The number of points allowed for the use of small-top pails has been increased from 3 points to 5 points. Under the subdivision "Utensils" the item "Facilities for steam 1 point (Hot water 0.5)" has been transferred to subdivision "Milk room or milk house."

The present study of dairy scores as compared with the quality of milk was made on the milk supply of a New York State city of about 14,000 people. The milk was produced from about forty farms. Nearly all of the farmers were grain and fruit growers and regarded the dairy as a minor source of income. For several years, the local health board had been exercising supervision over the sanitary conditions and consequently the dairymen were accustomed to inspection and score-card requirements. With the exception of two independent milkmen all of the milk was distributed by two retail companies to whom the producers delivered their milk each morning in 40-quart cans washed by the respective companies.

After becoming familiar with the application of each card the dairies studied were given three scorings at different times. In connection with the third scoring, a comparison was made between the bacteria counts and the barn scores. This was done during July and August of 1913.

BACTERIOLOGICAL EXAMINATIONS.

Methods of sampling.—Separate samples of night milk and morning milk from each producer were taken daily for one week directly from the can as it was placed upon the milk station platform. If a producer had several cans, a composite sample was taken from all of the cans containing milk of the same age. The milk in each can to be sampled was first stirred with a long-handled dipper by means of which a sample was transferred to a sterile pint milk bottle. At no time was night milk less than twelve nor more than fifteen hours old when delivered, while morning milk was never more than four hours old.

Plating.—The samples were taken at once to the laboratory and plated in lactose agar made according to the following formula:

Liebig's beef extract.....	5 grams
Witte's peptone.....	10 "
Agar.....	15 "
Lactose.....	10 "
Distilled water.....	1,000 c. c.

The acidity was determined and adjusted so that at no time was it less than 1.3 per ct. nor more than 1.5 per ct. normal acid to phenolphthalein. The plates were prepared in duplicate using two dilutions; and the period of incubation was 5 days at 21° C. (70° F.). Counting was done with the aid of a hand lens.

The milk from thirty-four producers was plated. Two of these used ice in cooling, while the remainder either used an aerator with running water or placed the cans in vats of water. The cooling was applied chiefly to night milk and nearly all of the morning milk was still warm when delivered. Thus the factors of age and temperature were fairly well known and are comparable. The temperature of practically all of the morning milk was above 68° F., while that of night milk ranged between 55° and 66° F.

In addition to the bacteria counts of the milk a sediment test was made for the insoluble dirt. This was done by filtering each pint of milk through a cotton disk after the sample had been taken for plating. Since no means was at hand for measuring and expressing the visible dirt, quantitatively, these results were left out of consideration. So far as could be observed, however, there was no relation between the amount of dirt visible on the cotton disk and the barn score. Some of the cleanest milk came from the lowest scoring barns.

EXPERIMENTAL DATA.

This discussion will be facilitated if the quality of milk is considered in the light of the bacterial requirements for the grades of milk established by the New York City Board of Health regulations and by the State Sanitary Code.¹ The bacterial requirements by New York City are as follows for each grade.

Grade A milk raw shall not at any time previous to delivery to the consumer contain more than 60,000 bacteria per cubic centimeter.

Grade A milk pasteurized shall not contain, previous to pasteurization, more than 200,000 bacteria per cubic centimeter; nor more than 30,000 after pasteurization.

Grade B milk must be pasteurized and shall not average, previous to pasteurization, more than 300,000 bacteria per cubic centimeter if pasteurized outside of the city; but if pasteurized within the city the maximum average allowed is 1,500,000 bacteria per cubic centimeter. After pasteurization it shall not contain more than 100,000 bacteria per cubic centimeter.

Grade C milk must be pasteurized and must not be sold if it contains more than 300,000 bacteria per cubic centimeter after pasteurization.

Where the bacterial standards are used for the grades of milk established by the State Code they are quite similar to those established by the New York City regulations. The requirements for Grade A milk raw and pasteurized are identical. Provision is made, however, for Grade B raw, the requirements being that this grade of milk shall not contain more than 200,000 bacteria per cubic centimeter at any time previous to delivery to the consumer. The requirements for Grade B milk pasteurized are similar to those for New York City except that nothing is said in regard to pasteurizing milk within a city and the bacterial requirement is so worded that no milk containing more than 300,000 bacteria per cubic centimeter can be pasteurized and sold as Grade B. This is a more stringent requirement than the New York City requirement. The State Code makes provision for both Grade C raw and Grade C pasteurized but places no limits upon the bacterial content of either. Both health departments exclude all milk which is produced in dairies that score below 40 points.

¹The Sanitary Code established by the Public Health Council of the State of New York, Chapter III Milk and Cream. Nov. 16, 1914. Issued by the New York State Department of Health, Albany, N. Y.

A COMPARATIVE STUDY BETWEEN THE BARN SCORES AND THE
BACTERIA COUNTS OF THE MILK.

Table I contains a summary of the results obtained from each of the farms studied in this investigation. The results are arranged with reference to the bacteria count of night milk, placing the lowest first. The scores made simultaneously with the three cards are placed opposite each count.

TABLE I.—A COMPARISON BETWEEN THE BACTERIA COUNT OF NIGHT MILK AND
THE DAIRY SCORES OF THIRTY-FOUR FARMS.

Farm number.	Plate count per c. c.		New York City score.		Official score.		Cornell score.
	P. M. milk.	A. M. milk.	Total.	Meth- ods.	Total	Meth- ods.	Total.
1.....	7,580	13,000	34	20	56.90	36.35	430 M*
2.....	54,000	57,000	43	28	53.65	36.50	446 M
3.....	98,000	.....	41	25	54.90	35.20	432 M
4.....	102,000	29,000	45	25	56.60	33.90	439 M
5.....	118,000	52,000	36	21	49.00	28.45	428 M
6.....	138,000	21,000	36	22	53.85	33.85	437 M
7.....	148,000	34,000	49	26	49.45	29.15	433 M
8.....	162,000	18,000	28	15	51.35	31.55	430 M
9.....	267,000	99,000	35	21	56.30	34.40	433 M
10.....	300,000	.....	31	19	45.95	29.10	401 M
11.....	313,000	.....	53	24	57.20	36.35	432 M
12.....	380,000	.....	39	22	54.15	31.75	416 M
13.....	537,000	907,000	57	30	55.70	31.90	442 M
14.....	538,000	165,000	35	18	50.10	32.15	422 M
15.....	570,000	610,000	45	22	48.70	29.05	435 M
16.....	687,000	58,000	73	41	73.08	38.63	469 G
17.....	732,000	.....	38	20	50.45	29.25	436 M
18.....	762,000	320,000	58	29	66.10	37.20	455 G
19.....	777,000	13,000	47	29	58.65	34.10	450 G
20.....	812,000	67,000	53	29	57.35	34.40	442 M
21.....	937,000	153,000	40	22	50.05	28.65	429 M
22.....	1,442,000	.....	50	29	49.75	27.75	413 M
23.....	1,758,000	45,000	39	23	54.95	32.05	447 M
24.....	1,758,000	103,000	35	23	49.65	32.15	439 M
25.....	2,700,000	.....	55	24	64.25	30.60	451 G
26.....	2,909,000	1,282,000	40	20	55.40	31.65	430 M
27.....	3,056,000	.....	27	14	59.00	37.45	439 M
28.....	3,158,000	88,000	40	27	55.90	31.15	433 M
29.....	3,167,000	.....	50	30	58.75	29.70	451 G
30.....	4,180,000	.....	86	50	79.40	43.35	481 E
31.....	4,215,000	.....	42	18	48.95	28.10	417 M
32.....	5,239,000	163,000	36	22	57.80	39.00	428 M
33.....	13,356,000	3,219,000	38	23	49.85	30.20	436 M
34.....	57,820,000	1,284,000	38	25	53.60	29.80	433 M

* E = Excellent, G = Good, M = Medium. See page 117.

The lack of relationship between the quality of milk as expressed by the bacteria count and the conditions surrounding its production as expressed by the barn score is the most striking thing noticed in a study of this table. Apparently no correlation exists between the bacteria count and the barn score as expressed by any one of the cards. In this particular series of analysis, all of the dairies with high scores produced milk with relatively high bacteria counts, while the best quality of milk from a bacterial point of view was produced in low-scoring barns.

Both the State Sanitary Code and the New York City Regulations specify in their requirements for Grade A and Grade B milk that a dairy must score at least a certain percentage in equipment and a certain percentage in methods. These two percentages, when added together, make the total minimum score required for each grade. It is possible for a dairy to be deficient in one of these and at the same time be nearly ideal in the other. In fact, it frequently happens that the excess in one sufficiently overbalances the deficiency in the other to cause the total score of the dairy to be high enough to meet the requirements for the next higher grade. Yet owing to the deficiency in methods or equipment the milk is placed in the lower grade. This condition actually happened in sixteen cases among those dairies scoring 55 per ct. and above. The deficiency, in every case but one, was in methods. On this account an objection may be raised to comparing the score of these dairies to the bacteria count of the milk produced, on the ground that, if these dairymen had improved their methods the bacteria count might have been lowered; a possibility which must be admitted.

It is usually thought that the methods employed in dairies are of greater importance in determining the bacteria quality of the milk than the equipment, yet if the bacteria count of the milk produced on the farms studied is compared to the score of methods alone (See Table I, columns 2, 5 and 7) it will be seen that the same lack of relationship exists as when the bacteria counts are compared with the total scores. For instance Farms 16 and 30 score considerably higher in methods than do any of the other farms, yet the milk produced from these two farms is markedly inferior to that produced from the first eight farms. According to the New York City card, the methods employed by twenty-eight dairy farms range in score between twenty and thirty points. Thus, so

far as the score is concerned, the methods of these farms vary but little while there is a great variation in the bacterial condition of the milk produced. A similar condition holds in regard to the scores for methods on the Official card.

A similar comparison can be made in Table III (Columns 2, 3 and 5) between the bacteria count for morning milk and the score for methods. Since this milk was only a few hours old when examined the question of bacterial growth due to age and insufficient cooling is less important, and a relationship would be shown if any were present. Since there is no evident relationship even in this case for either the Official or New York City cards it must be concluded that none exists.

There are four barns among the first eight in Table I which score below 40 per ct. (the point of exclusion) on the New York City card yet from which a milk is produced which could be pasteurized as Grade A milk so far as bacterial requirements are concerned. The milk from twenty-six of these dairies ranged in bacteria count from 267,000 to 57,820,000 per cubic centimeter. Of these, eleven score below 40 per ct. on the New York City card and would therefore be excluded from selling milk in that city. This leaves sixteen farms which would be allowed to sell milk so far as score is concerned. Among these are all of the dairies with high scores, several of which produced milk with higher bacteria counts than did some of the excluded dairies. If the score by the Official card were accepted as a basis none of the dairies would be excluded. There still exists, however, the same lack of correlation between the bacteria count and the scores as in the case of the New York City card. This same statement likewise applies to the Cornell card. In this series, high counts occur in milk produced in dairies rating as "Excellent," "Good" or "Medium" while the low count milk all comes from "Medium" dairies.

Farm 1 presents an interesting case. According to the New York City score this producer would be excluded. If the quality of milk were to be determined by the score alone it would be rated as distinctly bad. On the contrary, however, extensive bacteriological examinations of the milk from this farm show that such care was used in handling of the milk that it was invariably of excellent quality. During the months of April and May of the same year (1913) 23 samples of night milk gave an average plate count of 9,950 per cubic

centimeter — the highest being 34,000; while 23 samples of morning milk averaged 16,000 per cubic centimeter — the highest being 67,000. The low count obtained in the protracted study of the milk from this particular farm together with the low counts obtained in both morning and night milk from the first eight farms (Table I) clearly indicate that these farmers were consistent in observing care with regard to those factors most liable to produce a high bacteria count in the milk. In view of the high bacteria counts in milk produced in the high-scoring barns, it is evident that, if these factors are all included in the present score cards, then they either cannot be expressed mathematically or else they have not been given their correct mathematical value.

TABLE II.—SCORES ON LOW-SCORING AND HIGH-SCORING DAIRIES.

FARM 1.

Card used.	Date of inspection.	Scores for equipment.	Scores for methods.	Total scores.
New York City Card.....	Nov. 21, 1912	11	18	29
	Jan. 28, 1913	12	20	32
	July 10, 1913	14	20	34
	Oct. 23, 1913	14	18	32
Official Card.....	Nov. 21, 1912	19.90	29.00	48.90
	Jan. 28, 1913	18.95	30.90	49.90
	July 10, 1913	20.55	36.35	56.90
	Oct. 23, 1913	20.90	29.40	50.30
Score required to produce Grade C milk.....				40

FARM 30.

New York City Card.....	Dec. 3, 1912	30	52	82
	Feb. 6, 1913	29	50	79
	July —, 1913	36	50	86
Official Card.....	Dec. 3, 1912	33.90	42.70	76.60
	Feb. 6, 1913	34.45	46.45	80.90
	July —, 1913	36.05	43.35	79.40
Score required to produce Grade A raw milk.....		25	50	75

As will be seen, Farm 30 has a high bacteria count while the score entitles it to produce Grade A milk. Bacteriological examinations of the milk from this farm show comparatively wide fluctuations. One series of ten morning milk samples, taken during the

fall of 1912 gave an average plate count of 207,000 per cubic centimeter — the lowest being 55,000 and the highest 466,000. Another series of twelve night milk samples, taken in November, 1914, averaged 33,000 per cubic centimeter — the lowest being 5,200 and the highest 87,000. The factors which caused these variations are difficult to determine. Bacterially this milk fluctuated from Grade A raw to Grade C during the period of investigation. In this connection, it should be noticed that the scores made on Farms 1 and 30 did not change appreciably in inspections made at different times as shown in Table II.

According to the Cornell card, Farm 1 scored 416, 418, 430 and 434 and Farm 30—482, 482 and 481, respectively, the former being in the "Medium" class and the latter in the "Excellent" class.

Some may contend that it is unfair to compare the bacterial content of night milk and the barn score on the ground that the age of the milk and varying temperatures to which it had been subjected had had such a marked influence on the growth of bacteria that any possible relationship between score and bacteria count would have been completely obscured. This objection is offset to a considerable degree in a comparison which has been made between the score on the three cards and the bacteria count of morning milk reported upon in Table III. As previously stated, none of the morning milk was older than four hours at the time of delivery; and in only one case did the temperature average less than 68° F., while the highest was 77° F. Therefore these two factors were fairly well controlled or were, at least, of much less importance than in the night milk. There is little doubt but that the bacteria count under these conditions more truly indicates the initial contamination.

According to Table I, the milk of but two dairies qualifies bacterially as Grade A raw, while eight could qualify for the production of Grade A pasteurized. In Table III, however, the milk from ten farms could qualify as Grade A raw and seventeen as Grade A pasteurized. Among these seventeen, it will be noticed from Table I that there are several which had high bacteria counts in night milk. For instance Farms 23, 24, 28 and 32 gave bacterial counts above 1,000,000 per cubic centimeter in night milk. When this fact is considered in connection with the three series of counts made on Farm 30 (see page 123) it is clear that none of the scores keep pace with the wide fluctuations in bacteria counts.

TABLE III.—A COMPARISON BETWEEN THE BACTERIA COUNT OF MORNING MILK AND THE DAIRY SCORES OF TWENTY-THREE FARMS.

Farm number.	Plate count per c. c. A. M. milk.	New York City score.		Official score.		Cornell score.
		Total.	Methods.	Total.	Methods.	Total.
1.....	13,000	34	20	56.90	36.35	430 M*
19.....	13,000	47	29	58.65	34.10	450 G
8.....	18,000	28	15	51.35	31.55	430 M
6.....	21,000	36	22	53.85	33.85	437 M
4.....	29,000	45	25	56.60	33.90	439 M
7.....	34,000	49	26	49.45	29.15	433 M
23.....	45,000	39	29	54.95	27.75	447 M
5.....	52,000	36	21	49.00	28.45	428 M
2.....	57,000	43	28	53.65	36.50	446 M
16.....	58,000	73	41	73.08	38.63	469 G
20.....	67,000	53	29	57.35	34.40	442 M
28.....	88,000	40	27	55.90	31.15	433 M
9.....	99,000	35	21	56.30	34.40	433 M
24.....	103,000	35	23	49.65	32.15	439 M
21.....	153,000	40	22	50.05	28.65	429 M
32.....	163,000	36	22	57.80	39.00	428 M
14.....	165,000	35	18	50.10	32.15	422 M
18.....	320,000	58	29	66.10	37.20	455 G
15.....	610,000	45	22	48.70	29.05	435 M
13.....	907,000	57	30	54.70	31.90	442 M
26.....	1,282,000	40	20	55.40	31.65	430 M
34.....	1,284,000	38	25	53.60	29.80	433 M
33.....	3,219,000	38	23	49.85	30.20	436 M

* E = Excellent, G = Good, M = Medium. See page 117.

The lack of relationship between the bacteria counts and the scores is brought out more clearly in Table IV. Here the scores on each card are arranged separately and in order, beginning with the highest. This also shows how the three score cards compare when applied to the same dairies.

From this table, it is clearly seen that it is impossible to tell from which barn the best quality of milk is produced by means of any of these score cards. While bacteria counts do not have a direct relation to the presence or absence of disease germs, yet, within certain limits, they do indicate the care the milk has received. In so far as care tends to eliminate the dangers from communicable diseases, it cannot be justly claimed that the milk from the high scoring barns is safer than the milk from such barns as the first eight in Table I.

TABLE IV.—DAIRY SCORES OF THIRTY-FOUR FARMS ARRANGED IN ORDER WITH THE CORRESPONDING BACTERIA COUNT OF NIGHT MILK OPPOSITE.

NEW YORK CITY CARD.			OFFICIAL DAIRY CARD.			CORNELL CARD.			
Farm No.	Score.	Plate count per c.c.	Farm No.	Score.	Plate count per c.c.	Farm No.	Score.	Scores in per ct.	Plate count per c.c.
30	86	4,180,000	30	79.40	4,180,000	30	481 E*	88.6	4,180,000
16	73	687,000	16	73.08	687,000	16	409 G	81.4	687,000
18	58	762,000	18	66.10	762,000	18	455 G	73.0	762,000
13	57	537,000	25	64.25	2,700,000	25	451 G	70.6	2,700,000
25	55	2,700,000	27	59.00	3,056,000	29	451 G	70.6	3,167,000
20	53	812,000	29	58.75	3,167,000	19	450 G	70.0	777,000
11	53	313,000	19	58.65	777,000	22	447 M	68.2	1,758,000
29	50	3,167,000	32	57.80	5,239,000	2	446 M	67.6	54,000
23	50	1,442,000	20	57.35	812,000	13	442 M	65.2	537,000
7	49	148,000	11	57.26	313,000	20	442 M	65.2	812,000
19	47	777,000	1	56.90	7,580	4	439 M	63.4	102,000
4	45	102,000	4	56.60	102,000	24	439 M	63.4	1,758,000
15	45	570,000	9	56.30	267,000	27	439 M	63.4	3,056,000
2	43	54,000	28	55.90	3,158,000	6	437 M	62.2	138,000
31	42	4,215,000	26	55.40	2,909,000	17	436 M	61.6	732,000
3	41	98,000	22	54.95	1,758,000	33	436 M	61.6	13,356,000
28	40	3,158,000	3	54.90	98,000	15	435 M	61.0	570,000
26	40	2,909,000	13	54.70	537,000	7	433 M	59.8	148,000
21	40	937,000	12	54.15	380,000	28	433 M	59.8	3,158,000
22	39	1,758,000	6	53.85	138,000	34	433 M	59.8	57,820,000
12	39	380,000	2	53.65	54,000	9	433 M	59.8	267,000
34	38	57,820,000	34	53.60	57,820,000	11	432 M	59.2	313,000
17	38	732,000	8	51.35	162,000	3	432 M	59.2	98,000
33	38	13,356,000	17	50.45	732,000	26	430 M	58.0	2,909,000
32	36	5,239,000	14	50.10	538,000	1	430 M	58.0	7,580
6	36	138,000	21	50.05	937,000	8	430 M	58.0	162,000
5	36	118,000	33	49.85	13,356,000	21	429 M	57.4	937,000
9	35	267,000	23	49.75	1,442,000	32	428 M	56.8	5,239,000
14	35	538,000	24	49.65	1,758,000	5	428 M	56.8	118,000
24	35	1,758,000	7	49.45	148,000	14	422 M	53.2	538,000
1	34	7,580	5	49.00	118,000	31	417 M	53.2	4,215,000
10	31	300,000	31	48.95	4,215,000	12	416 M	49.6	380,000
8	28	162,000	15	48.70	570,000	23	413 M	47.8	1,442,000
27	27	3,056,000	10	45.95	300,000	10	401 M	40.6	300,000

* E — Excellent, G — Good, M — Medium. See page 117.

A COMPARATIVE STUDY OF THE SCORES OBTAINED BY THE THREE CARDS.

It is not the purpose to take up in this bulletin a detailed consideration of the dairy operations or conditions specified on the score cards and compare the cards in this way. A comparison has been made merely between the final scores obtained.

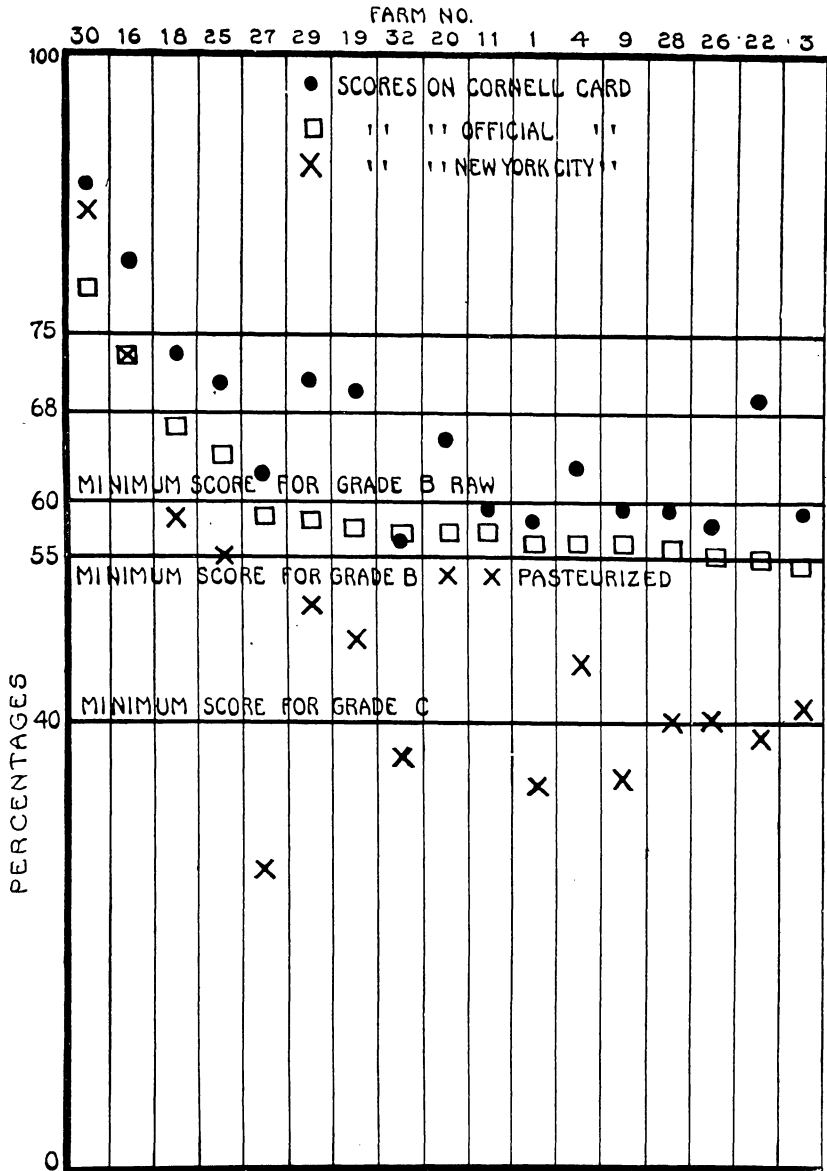
The Official card and the New York City card are very similar in their general plan. In fact, each card scores on the basis of 100 per ct., and in this respect they are identical. The Cornell card, however, is drawn up on an entirely different plan and, in order to compare, it was therefore essential to reduce the rating of the card to a percentage basis.

When this is done it will be seen that 400, which is the dividing line between "Medium" and "Poor" dairies, equals 80 per ct. In other words a dairy must stand at least 80 per ct. to pass, while 40 per ct. is the passing mark established in the regulations of both the New York State Board of Health and the New York City Board of Health. Because of this wide difference in the exclusion points it was necessary to still further transform each Cornell score in order to make the basis of scoring the same as that of the other two cards. In Table IV each Cornell score is thus transformed (Column 9).

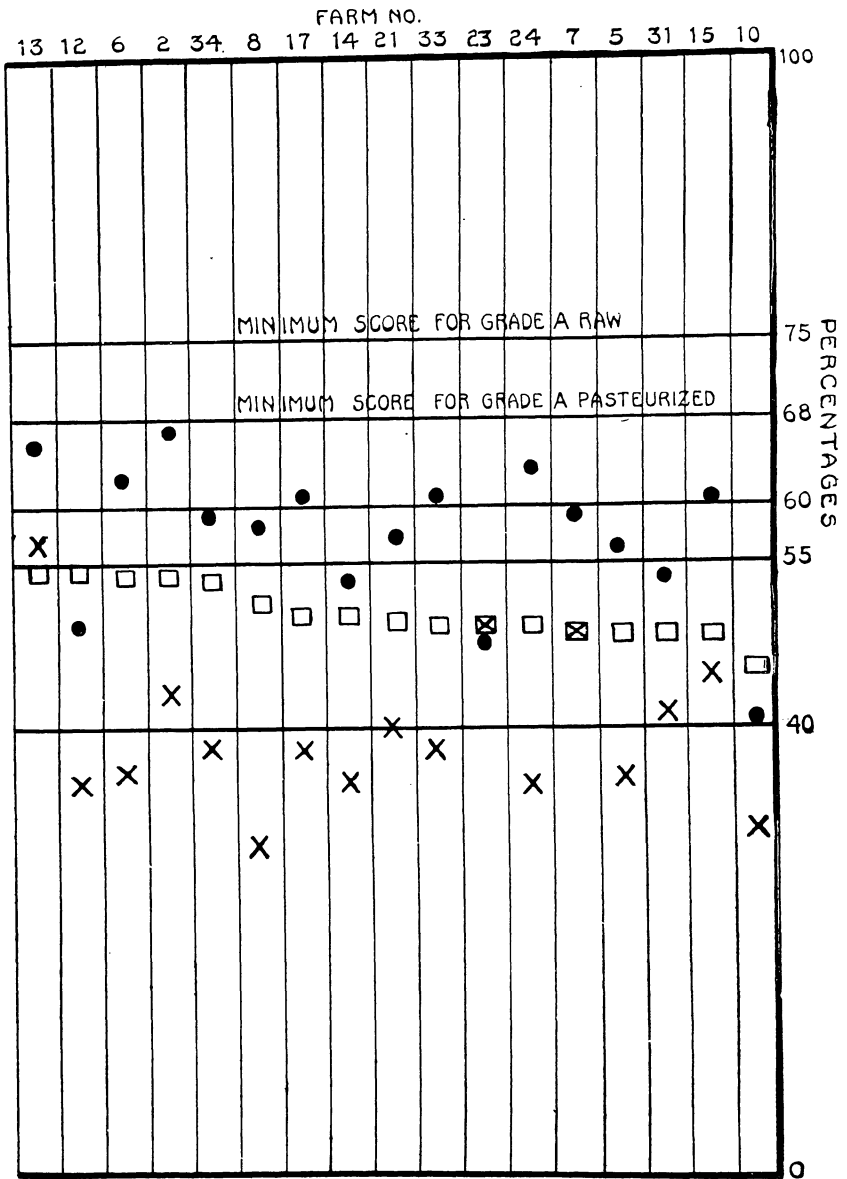
The actual comparison between the three cards is shown more clearly in Graph 1 (pages 128 and 129). The horizontal lines in this graph represent the minimum scores for each grade of milk established by the regulations of both the New York State Board of Health and the New York City Board of Health. The spaces between the vertical lines represent each dairy scored. The numbers of the dairies as given in Table I are placed at the top of the graph. The scores are shown graphically as follows: solid black dot indicates score on Cornell card, hollow square the score on Official card and the cross the score on the New York City card. The scores are arranged with reference to those obtained on the Official card.

It is evident from this graph that the Cornell card is the most lenient. This is shown by the fact that of the 34 dairies, the total scores of 29 were high enough to entitle them to produce Grade A or B milk, while according to the scores on the Official card only 16 dairies were entitled to this privilege and only 5 according to the scores on the New York City card. The Cornell card rates only 5 dairies as Grade C, while 18 are thus rated on the Official card and 14 on the New York City card. None of the dairies scored below the exclusion point on either the Cornell or the Official card, while 15 dairies scored below this point on the New York City card.

It is further evident that there is little agreement between the scores obtained by the three cards when applied to the same conditions. This, of course, is largely affected by the different interpretations used. In this investigation, however, there was an agreement among the three cards as to the three dairies which would be considered the best from the standpoint of scores. These dairies also occupied the same relative position on each card. Beyond this there were instances of wide variations. The scores obtained by



GRAPH I.—COMPARATIVE SCORES OF THIRTY-FOUR



DAIRIES BY THREE SCORE-CARD SYSTEMS OF RATING.

the Official card and the Cornell card agreed as to the poorest scoring dairy, while there was a slight variation in the rating of this particular dairy on the New York City card. As will be seen from the graph, however, the variations between the scores on the Official card and the Cornell card are not so great as between the New York City card and either of the other two. The greatest variation found is in the case of Farm 27 which scores at the foot of the list on the New York City card but scores 32 points higher on the Official card, rating fifth from the top, while the score on the Cornell card is 5.4 points higher than that of the Official card and is 37.4 points higher than the New York City card, and rates thirteenth from the top.

It should be kept in mind that these comparative scores are discussed in this paper with reference to the interpretation gained by the author while working with inspectors trained in the application of the respective cards. Since different interpretations exist, it is quite probable that other systems of cuts than those used would give somewhat different results. It may be that both the New York City and Official cards could be so interpreted that the results secured would compare closely. This tendency to vary the interpretations put upon the cards is one of the weaknesses of all of the present score cards as a means of grading milk, which has been generally recognized.

CONCLUSIONS.

The originators of the present score cards evidently had two purposes in mind, first that the cards should act as guides in instructing the producers in the importance of cleanliness in the handling of milk, and second that they should serve as records of the sanitary conditions. The use of these cards has caused a widespread belief to grow up that there is a correlation between the actual quality of the milk and the score of the barn conditions. This belief is undoubtedly becoming more firmly fixed in the mind of the general public and will undoubtedly become more so as a result of the rules and regulations governing the grading of milk and cream in this State, issued by the Public Health Council. According to these regulations local health officials are allowed a choice; that is, they may grade milk and cream by means of bacteria counts and dairy scores combined, or they may do the grading by means of the dairy scores alone. The second choice, under which no Grade A

milk can be placed on the market, implies a relationship between the quality of the milk and the score which is not borne out by the present investigation.

In so far as the quality of milk can be determined by present laboratory methods, there exists no relationship between the quality of milk and the dairy score on the score cards now in use. Milk of all grades, ranging from the finest quality to the poorest, is produced in barns which would be excluded on account of low scores. All grades of milk are likewise produced in the high-scoring barns.

The real explanation for this lack of relationship between the scores and the bacteria counts cannot be given as yet with absolute certainty. The most apparent reason, as shown by investigations made at this Station, is that a large number of the items included on the score card have little or no effect upon the number of bacteria present in the milk. In other words, too great emphasis is placed upon unessential factors in all of the score cards studied, with a consequent lessened emphasis upon the factors which actually do affect the milk.

Some may contend that these findings encourage the production of milk under filthy conditions. This contention will be raised only by those who hold the idea that low-scoring dairies are necessarily unsanitary and filthy. Such conditions have, however, not been found to hold true in the region studied because low-scoring dairies were found which vied in cleanliness with the most ideal of the high-scoring dairies. On the contrary, however, these facts give decided encouragement to the intelligent dairyman who finds that he can produce high-grade milk by the simple observation of the few essential factors of cleanliness and care. This places him in a position to secure a greater profit from his business while at the same time he has the moral satisfaction of knowing that he is selling a high-grade article. Where the present score cards are used, all dairies, in order to get credit for Grade A milk, are forced to an additional expense and consequently to an increased cost of production. At the same time a compliance with the score-card requirements carries with it no guarantee that the quality of milk will be improved or rendered more safe from the standpoint of public health.

The fact that high-grade milk can be produced with simple equipment, likewise gives encouragement to the consumer who is as much

interested in keeping down the cost of producing high-grade milk as is the producer.

None of the results secured in this investigation can be so construed as to disprove the value of dairy score cards, but they do show that present score cards cannot be satisfactorily used as a means of grading milk according to quality. There is little hope of designing a score card which will accomplish this purpose until all of the factors which are thought to affect the quality of milk in any way have been carefully studied; and the influence of each determined and accurately measured. In this way the really important factors can be singled out and given the proper values on the score card.

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