New York Agricultural Experiment Station.

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ILLINOIS, CORNELL AND WISCONSIN AGRICULTURAL EXPERIMENT STATIONS.

WHAT IS MEANT BY "QUALITY" IN MILK.

R. S. BREED, H. A. HARDING, W. A. STOCKING, Jr.,
AND E. G. HASTINGS.

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FOREWORD.

For many years the Official Dairy Instructors Association, which has recently become the American Dairy Science Association, has maintained a committee on dairy score card, which committee is responsible for the so-called "official" dairy score card. In 1912 this committee recognized the necessity for a different score card evaluating the quality of milk rather than the conditions under which milk was produced, and formed a subcommittee to study this problem. This subcommittee was later made an Association committee on milk quality. Extensive investigations have been conducted, particularly at the New York Agricultural Experiment Station and the Illinois Agricultural Experiment Station, at Urbana, in connection with this study, and the present publication is an analysis of the problem of milk quality as it appears to this committee after these years of study.

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WHAT IS MEANT BY "QUALITY" IN MILK.

R. S. BREED, H. A. HARDING, W. A. STOCKING, Jr.,
AND E. G. HASTINGS.

INTRODUCTION.

Milk is often called good or bad, but it is difficult to define either quality. It needs but a slight study of the milk question to recognize that the goodness or badness of milk depends upon several factors. Because of the complexity of this situation there is much confusion in the public thought regarding quality in milk. As a result, milk is still commonly sold without the use of grades to designate quality, the State of New York being one of the few exceptions to this rule.

The present publication is a brief summary of previous considerations of the various sides of this question, a plea for a broader consideration of the problem of milk quality, and a suggestion regarding the line along which future progress in the improvement of city milk supplies will undoubtedly be made.

ELEMENTS OF QUALITY IN CITY MILK.

Many factors combine to determine the quality of milk. Each of the factors has been recognized as important at one time or another, but apparently thus far no one has succeeded in so fully analyzing the city milk situation as to formulate a complete expression for milk quality. The following summary1 of the elements of quality in city milk under the headings of food value, healthfulness, cleanliness, and keeping quality is an attempt at such an analysis. The order of presentation of these elements is essentially that in which they have been previously brought to public attention.

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1 This summary of elements of quality in city milk does not consider the occasional occurrence in milk of disagreeable substances, of which onions and gasoline are the most common examples, because the evident presence of such substances automatically excludes such milk from the city trade.

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FOOD VALUE.

While milk is sometimes used as a beverage, the fundamental reason for the existence of the present vast traffic in milk is the fact that milk is one of our most important foods. Not only does it offer energy in a readily available form, but the amount and variety of the compounds contained in milk make it a peculiarly valuable food for growing children. The present consumption of milk in this country is only about 0.6 pint per capita per day, altho from the standpoint of protein, which is especially needed by the growing child, or from the standpoint of total energy as utilized by the adult, much more food value is obtainable from milk for a given sum of money than can be purchased in any comparable food. The high food value of milk is shown by the following table recently prepared by the U. S. Department of Agriculture:

<table>
<thead>
<tr>
<th>PROTEIN</th>
<th>ENERGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 quart of milk is equal to:</td>
<td>1 quart of milk is equal to:</td>
</tr>
<tr>
<td>7 ounces of sirloin steak</td>
<td>11 ounces of sirloin steak</td>
</tr>
<tr>
<td>6 ounces of round steak</td>
<td>12 ounces of round steak</td>
</tr>
<tr>
<td>4.3 eggs</td>
<td>8 1/2 eggs</td>
</tr>
<tr>
<td>8.5 ounces of fowl</td>
<td>10.7 ounces of fowl</td>
</tr>
</tbody>
</table>

In 1856 the laws of Massachusetts\(^2\) attempted to protect milk from adulteration and since that time federal, state, and municipal authorities have enacted laws establishing standards for butter fat and the other solids in milk. It was the original conception that milk is of essentially fixed composition and that the establishment of minimum standards would stop the watering and skimming of milk. The establishment of these legal standards undoubtedly has had a pronounced effect in limiting open and gross adulteration of milk, but the secondary and unexpected effects of such enactments have been such as to raise the question whether, taken as a whole, they have been beneficial to the quality of the milk supply.

While it is true that these legal standards set definite limits to the extent to which the food value of milk could be reduced without incurring the penalty of the law, at the same time they offered indirectly a stimulus for the reduction of such food value to a figure approximating these legal minimum standards.

\(^2\) Parker, H. N. City Milk Supply, p. 370. 1917.
The cost of producing milk at the farm is fairly proportional to the amount of food value in the milk. With the narrow margin of profit which exists in milk production, there has been a strong impelling force toward the production of milk with the smallest food value that the market would accept without reduction in price. When the law prohibited the reduction of food value by the direct addition of water, the same result was frequently accomplished by the selection of animals producing milk which approached or even fell below the legal minimum limits. It is a matter of common knowledge that the milk supplies of our larger cities have been falling in food value, and today much of the milk sold in such cities is almost exactly at the legal limit of fat and below the legal limit in solids not fat.

This reduction in food value is all the more striking in view of the marked preference which the consuming public has for milk of high food value. Many progressive milk dealers, recognizing this situation, have offered milk high in fat content at an advanced price with commercial success.

While there is no simple, and at the same time, entirely satisfactory method of expressing the food value of milk, it may be roughly measured in a variety of ways. The housewife customarily judges the food value of milk by noting the depth of the cream line in the milk bottle. The food values of the other constituents of normal milk do not vary in absolute proportion to the fat, and therefore the fat is not an entirely accurate measure of the food value of the milk; but, at the same time, the variations in total food value are so nearly proportional to the variations in the fat of the milk that the fat content of milk of cows may well be used as an index of the relative food value of various samples of milk. This index has the added convenience of being easily and accurately determined by means of the Babcock test.

**HEALTHFULNESS.**

It is not enough that a bottle of milk shall have abundant cream in order to be accurately characterized as good milk. If such milk should contain even a limited number of virulent typhoid-fever organisms, it would be rejected by anyone who was acquainted with this fact. While the milk business is conducted primarily because milk is a valuable food, the occasional appearance of an epidemic
spread by the use of milk has made the public suspicious of the healthfulness of all milk. This public suspicion is a severe handicap to the milk business, and any procedure which will remove this suspicion and stimulate the increased consumption of milk will be of great economic benefit to the dairy industry as well as to the consumer.

While the possibility of milk functioning as a carrier of disease had been previously discussed, beginning about 1893 the use of the tuberculin test revealed a large amount of tuberculosis in dairy cattle and the public was impressed with the danger of spreading tuberculosis thru the milk. Later investigations, particularly those made during the past fifteen years, have fully demonstrated the danger of tuberculosis being transmitted from cows to children thru the milk. Occasional epidemics of septic sore throat and typhoid fever and less frequently epidemics of scarlet fever and diphtheria transmitted in the same way have given good grounds for suspicion regarding the healthfulness of the ordinary raw milk supply. The amount of danger from this source is commonly overestimated, but its existence, particularly in the case of children, is beyond question and should not be overlooked.

Health authorities, early recognizing tuberculosis of cattle as a public menace, attempted to stamp it out by the widespread application of the tuberculin test. The difficulties encountered in such an attempt made it evident that whatever may be the value of the tuberculin test as such, there is little prospect that the application of the test will become so widespread as to offer protection to the general milk supply.

It has also been recognized that tuberculosis is only one of a number of diseases which may be distributed thru the milk supply. Any plan which is to make milk a safe article of food must take account,

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5 Trask, J. W. Milk as a Cause of Epidemics of Typhoid Fever, Scarlet Fever, and Diphtheria. Public Health and Marine Hospital Service of the United States, Hygienic Laboratory Bul. 56, pp. 23-149. 1909.
not only of diseases which may be transmitted from the cow, but also of the more formidable list of diseases which may be transmitted by the milk from the people who handle it to those who consume it. The history of certified milk has made it evident that a careful medical supervision of both animals and men will reasonably protect the milk from danger of transmitting human diseases, but the expense of such supervision is large.

Pasteurization of milk was early advocated as a means of safeguarding the consumer from the dangers, not only of tuberculosis, but of other transmissible diseases. As with the tuberculin test, so with pasteurization, many practical difficulties were encountered in applying the process to the milk supply.

The studies of Theobald Smith and of Russell and Hastings which pointed out the practicability of pasteurizing milk at 140° F. for thirty minutes, mark the real beginning of modern successful milk pasteurization. This pasteurization, which both gives the desired protection against disease germs and furnishes a product satisfactory to commercial milk requirements, was the beginning of a widespread general interest in the subject. This interest has grown to the point where the regulations of the largest cities and of some of the smaller cities make such pasteurization of the general milk supply compulsory. In some instances this movement toward pasteurization has even taken the form of state enactment.

It is evident that if the milk supply is to be made so safe as to banish the suspicion of danger from disease germs, which is now a factor limiting the consumption of milk, the milk must either be produced under a careful medical supervision regarding the health of the cows and men or it must be properly pasteurized.

CLEANLINESS.

In order to conform to the general opinion of a good milk, it is not sufficient that a milk shall have high food value and shall be

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free from danger of disease. If at the bottom of the bottle of milk there is a distinct sediment, the purchasing public will uniformly reject the milk as being of poor quality. The public is justly desirous of having a clean food supply, and there is probably no food product regarding which it is more sensitive than milk. The extreme sensitiveness of the public in this matter is due in part to the fact that milk naturally lends itself to careful inspection. The white milk forms a natural background against which any foreign matter stands out with startling distinctness. As a result of these physical conditions the unaided eye is able to detect the presence of foreign matter in milk when it is present in such minute quantities as to practically defy detection by analytical methods. The sensitiveness of this inspection is shown by the fact that it is possible thus to find traces of foreign matter in practically any quart of milk which is critically examined, regardless of the care exercised in its production. In the certified milk from the cleanest dairies in the country which is annually brought together in competition at the National Dairy Show, such foreign matter is evident to the eye in over 80 per ct. of the bottles. On the other hand, the amount of this foreign matter is so slight in all certified milk, and in practically all commercial milk, as to be upon the very margin of detection by analytical methods.

Taking advantage of the sensitiveness of the eye to differences in color, a method called the sediment test⁹ has been devised for determining the cleanliness of milk. In applying this sediment test, measured quantities of milk are passed thru cotton and the dirt is observed as a residue upon the white cotton. This test has been quite widely applied in commercial work. While in rare cases the presence of considerable amounts of dirt has been demonstrated, in practically all instances the amount of dirt found in the milk has been slight. When attention has been directed to the presence of any considerable quantities of dirt, the conditions of milk production have been promptly modified so as to bring the milk to a uniformly high standard of cleanliness.

Milk as it is now generally produced and handled is one of our cleanest foods.

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KEEPING QUALITY.

In order that a milk shall be justly entitled to be called good milk, it is not sufficient that it be high in food value, that it be free from danger of carrying disease, and that it be clean, because if it is sour when delivered to the consumer or sours promptly thereafter, it is unsatisfactory. In the northern states, at least, the delivery of milk once a day is expected to supply the needs of the family for the succeeding twenty-four hours. Accordingly, good milk must remain sweet during that period, and preferably during a longer period, in order to justly entitle it to be called good.

It is possible to estimate the condition of the milk with regard to food value, healthfulness, and cleanliness, by comparatively simple methods. The situation with regard to keeping quality is more complex. Souring is induced by the growth in the milk of minute forms of plant life—bacteria. This plant life attacks the sugar of the milk, using it as a food, and producing acid as a by-product. When the accumulation of this acid amounts to approximately 0.3 per cent., the milk begins to taste sour; and when the accumulation of acid has reached approximately 0.7 per cent., the milk curdles. The problem of maintaining a satisfactory keeping quality is essentially a problem of restricting the development of germ life. It is possible to meet this problem either by preventing the entrance of germs, by destroying them after they enter, or by holding the milk under conditions which will prevent the activity of the germs after they enter.

While the problem of the keeping quality of milk can thus be stated in simple terms, the actual restriction of contamination and of development of germ life is a complex matter. There is still a lack of knowledge regarding the relative importance of the various avenues thru which bacteria gain access to the milk, and this results in a lack of knowledge regarding the most practicable means of preventing their entrance.

In attempting to control keeping quality, various cities have made regulations establishing a maximum number of germs permissible in their milk supplies. These regulations did not attain the desired results, and in many cases the cities further stipulated various conditions which must accompany milk production. The establishment of

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bacterial standards placed upon the milk producer and the milk dealer the responsibility of translating these standards into terms of dairy processes, while the detailed recommendations formulated by the health authorities are an attempt on their part to make this translation. In practice both these attempts have failed to accomplish the desired end. As a measure of the keeping quality there are many advantages in a direct\textsuperscript{11} determination of the germ life, but this is a technical process not readily available to the dairymen and accordingly has certain limitations.

The true measure of the keeping quality of milk is the time which elapses before it actually sours. This is the measure employed by the consumer, but manifestly it cannot be applied in advance at any earlier stage in the commercial life of the milk. A modification of this is possible in that samples of the milk under consideration may be held at high temperatures and the interval before curdling noted. From a comparative study of the effect of a temperature on germ growth, it would then be possible to translate this interval into the time which would elapse before the original milk would sour at the lower temperature at which it would normally be held. This procedure involves some time and technical apparatus which is not often available.

The commercial milk men have long employed the acid test, as well as their trained sense of taste and smell, in estimating the probable keeping quality of milk as delivered at their plants. By these means they have been able to anticipate somewhat the time at which milk will be no longer acceptable to the whole-milk trade, but it is only as milk approaches this limit that its condition is determinable by these means.

During the past few years there have been suggested a number of technical milk tests more or less closely related to keeping quality, such as the reductase test, the Schardinger reaction, the alcohol test, the catalase test, and the hydrogen ion concentration. In general the availability of these tests seems limited because they are mainly useful only in the later stages of the commercial life of milk.

In view of this unsatisfactory condition of knowledge regarding the measurement and control of the keeping quality of milk, the

New York\textsuperscript{12} and Illinois\textsuperscript{13} Agricultural Experiment Stations have undertaken extended and detailed study of the various factors affecting the entrance and growth of germ life in milk.

**COMPLEXITY OF THE PROBLEM.**

The above outline of the various phases of milk quality brings out the fact that at various times the students of the milk question have been interested first in one, then in another element of milk quality, and that in connection with each such attempt they have succeeded in devising a more or less successful index of quality with regard to the particular point under observation.

This publication is designed to emphasize the fact that the quality of city milk is not a simple matter to be adequately expressed after a consideration of any one factor, but that it is a complex matter which can be expressed only after an adequate consideration and evaluation of each of these four essential factors; namely, food value, healthfulness, cleanliness, and keeping quality.

While the percentage of fat in milk is not a perfect measure of the food value, it is an easily determined index of food value. While medical supervision of the health of the cows and the men or proper pasteurization are not absolutely self-sufficient guarantees of the healthfulness of milk, they are the most practicable and easily applied indices of healthfulness. The sediment test, while open to some objections, is a simple and easily applied index of milk cleanliness. The problem of a satisfactory index for keeping quality is not so simply solved. Among the many available tests, that one must be selected which will best suit the purpose in hand.


Much of the confusion in the public mind regarding milk quality has been due to a failure to discriminate properly between germ content and healthfulness, on the one hand, and germ content and cleanliness, on the other.

The introduction of the public to the subject of germ life came thru the attention which was early given to germs as producers of diseases such as tuberculosis\textsuperscript{14} and typhoid fever. To the public, bacteria and disease became practically synonymous words. Later the attention of the public was directed to germ life in milk\textsuperscript{15} at about the same time that its attention was directed to the possibility of germs of tuberculosis\textsuperscript{16} being present in milk. Therefore, it is not at all strange that in public thought germ life and unhealthfulness of milk should have seemed identical.

Early in the present century Metchnikoff\textsuperscript{17} and other writers began to lay stress upon the health-giving qualities connected with certain germs in milk, as those of the Bulgaricus group. More recently extensive commercial use has been made, not only of cultured milks of various kinds, but also of vast quantities of buttermilk containing the ordinary sour-milk organisms with or without the addition of cultures of the Bulgaricus forms. There is a continued satisfactory use of these sour-milk drinks which contain many millions or billions of bacteria per cubic centimeter, not only of these special organisms with foreign names, but also of the organisms present in our sour milk of commerce. These experiences are gradually bringing home to the public an appreciation of the fact that there is very little connection between the amount of germ life in milk and the healthfulness of milk.

The confusion in the public thought between the presence of germ life and cleanliness arises from the fact that it was originally believed that the seeding of milk with bacteria came about primarily as a result of a large quantity of bacteria being carried into the milk upon various forms of foreign matter, such as dirt and dust. Each particle

\textsuperscript{17} Metchnikoff, E. The Prolongation of Life. 1908.
of dust in the barn air was looked upon as an omnibus overloaded with attached germ life.

More recent studies have shown that dust particles, instead of being loaded in the manner described, are actually in all but less than one case out of a hundred entirely free from any living organisms. 18 While it is true that small numbers of germs are carried into the milk upon dirt, the amount of dirt actually finding its way into the milk is so small in proportion to the mass of the milk that the germ life added in this way is relatively insignificant. The confusion regarding bacteria in milk is being cleared up by studies which show that the real source of contamination of milk is either an unusual population of bacteria in the udder, or far more frequently, the presence of a surprisingly large amount of germ life upon the utensils in which the milk is handled. So persistent is this idea of the constant association of germ life and dirt that the natural inference would be that utensils carrying large numbers of germs were dirty. This inference is not in accord with the carefully observed facts, since germ life is present in vast numbers upon dairy utensils which have been rendered clean in the ordinary sense of the word, but which have not been so handled as to obliterate germ life.

Later studies of germ life in the udder 19 have made it plain that germ life is constantly present in all samples of normal milk from the time it is secreted by the glands of the udder to the time it is utilized by the consumer.

Too frequently the public thinks of milk merely as a fluid containing butter fat, while it should of course recognize the fact that milk

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18 Compare, for example, the number of dust particles per cubic foot of air as reported on page 61 of Final Report of the Committee on Standard Methods for the Examination of Air (Am. Jour. Pub. Health 7: 54-72, 1917), where the number of dust particles per cubic foot of the air of New York City streets is given as between 400,000 and 1,000,000, as determined by the filtration method, with the number of bacteria per cubic foot of air as reported by Winslow, C. E. A., and Browne, W. W. (The Microbe Content of Indoor and Outdoor Air. Monthly Weather Review 42: 452-453, 1914). The average numbers of bacteria which the latter authors report do not exceed 113 per cubic foot for air from the open country, from city streets, from offices, from factories, and from schools.


also normally contains about 5 per ct. of milk sugar, as well as varying amounts of nitrogenous substances which become most prominent in such things as cottage cheese. Until a few years ago, few people appreciated that in the process of milk secretion, worn-out gland cells and blood corpuscles are thrown off into the milk and form a part of normal milk, since they are uniformly and regularly present in considerable numbers in all milks. The recentness of our appreciation of the normal presence of these cells in milk is shown by the fact that up to a few years ago in certain cities there existed regulations forbidding the presence of what are now known to be fairly normal quantities of these cells in milk.

While the public is generally aware of the fact that milk always contains considerable quantities of germ life, it has probably not yet come to appreciate the fact that germs in milk are just as constant, and therefore just as normally a part of milk, as are milk sugar, fat globules, and body cells. The consumer has little interest in the germ content of milk except for a limited number of disease-producing forms against which he has a right to insist upon adequate protection, and except in so far as the germ life produces objectionable changes such as souring or bad flavors in the milk itself.

COMPOSITE EXPRESSIONS OF QUALITY.

As has already been stated, the students of milk have recognized more or less distinctly the various elements of milk quality. However, the public mind insists upon a simple, direct statement of quality regardless of the complex relationship involved. It insists that a milk must be good, medium, or bad. Various plans have been devised for meeting this demand and furnishing a composite expression for milk quality.

CERTIFIED MILK.

Certified, as applied to milk, signifies that it has the food value of normal 4-per ct. milk, the healthfulness resulting from a careful medical supervision of all animals and men connected with the production and handling of the milk, the cleanliness following careful attention to the cleanliness of the animals and the utensils, and the

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keeping quality to be expected of fresh milk with a low germ content, kept at a very low temperature.

SCORE CARD.

As a measure of the desirability of the ordinary milk supply, various dairy score cards have been suggested. These score cards are an attempt to express on a percentage basis the protection given milk on the farm from the danger of contamination with disease-producing germs both from animals and from men (healthfulness); the protection given milk from dirt (cleanliness); and the protection given milk by care of utensils, by cooling, and by prompt delivery (keeping quality). These score cards have uniformly failed to take account of the food value of the milk. Since these score cards are arranged on the basis of the agricultural methods and equipment rather than on the basis of the milk, it is but natural that in the cards themselves there should be much confusion regarding the items which apply respectively to healthfulness, cleanliness, and keeping quality. Some have expected to find correlation between germ content and the dairy score; others feel that there should be a correlation between cleanliness of the milk from dairies and the dairy score; while others expect a correlation between the score of the dairy and the presence or absence of disease germs. Such comparisons on the basis of a single element of equality are necessarily unfair to the score card unless it is recognized that the dairy score combines factors connected with all three elements of quality.

The essential difficulties of present score cards arise from the fact that they are an attempt to evaluate the influence of dairy environment and processes upon the milk, when the relative importance of such factors has not yet been sufficiently determined.

Grade.—This presentation would be very incomplete if it did not include a suggestion as to the manner in which the four elements of milk quality herein discussed might be combined so as to form a basis for defining grades of milk. The following is offered as a suggestive outline rather than as a finished plan for milk grading:

<table>
<thead>
<tr>
<th>GRADE</th>
<th>ELEMENT OF QUALITY</th>
<th>DEGREE OF EXCELLENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special milk</td>
<td>Food value</td>
<td>Fat content as stated on package</td>
</tr>
<tr>
<td></td>
<td>Healthfulness</td>
<td>Medical supervision of health of men and animals, or proper pasteurization</td>
</tr>
<tr>
<td></td>
<td>Cleanliness</td>
<td>Sediment, not more than a trace</td>
</tr>
<tr>
<td></td>
<td>Keeping quality</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
GRADE. ELEMENT OF QUALITY. DEGREE OF EXCELLENCE.

Table milk
Food value Fat content as stated on package
Healthfulness Properly pasteurized
Cleanliness Sediment, not more than a small amount
Keeping quality Good

Cooking milk
Food value Fat content as stated on package
Healthfulness Boiled
Cleanliness May not be sufficient for table grade
Keeping quality May not be sufficient for table grade

Under the grade of special milk, the plan provides for milk of any desired composition to meet any special need, such as baby feeding. The grade of table milk will normally include the ordinary city supply. The grade of cooking milk is designed for milk not sufficiently fresh or not carefully enough handled to be suitable for the table grade. In order to assist in protecting the consumer from unwittingly purchasing cooking milk instead of table milk, it is suggested that cooking milk be boiled. Such treatment will adequately protect healthfulness, and while making this grade of milk readily recognizable, will not injure it for the use for which it is designed.

RESPONSIBILITY OF THE PRODUCER FOR MILK QUALITY.

If the foregoing analysis of milk quality is correct, the producer sustains relations to each of the elements of milk quality somewhat different from what has been ordinarily supposed. Contrary to current belief, he is unable to control food value to any appreciable extent by his method of feeding the cow. The forces of heredity have determined what shall be the composition of the milk of a given animal, and except for slight seasonal variations or local disturbances a cow persists in giving milk of essentially a fixed composition. On the other hand, by selecting his animals he is able to produce milk of widely different food value, but at a correspondingly different cost of production.Manifestly, it must be expected that he will produce a milk having a food value which will give him the widest margin of profit.

In the matter of healthfulness, the producer has the responsibility of protecting, in so far as he is able, the milk supply from contamination by disease-producing organisms derived either from cows or people. His recognized inability satisfactorily to protect milk in this
way calls for the added protection of medical supervision of the health of the cows and men, or of pasteurization; but medical inspection and pasteurization are, manifestly, not the producer's problem.

The element of cleanliness is largely in the control of the producer. Under present economic conditions, he is producing a milk with a very high degree of cleanliness, and if any additional stress is laid upon this point he will undoubtedly produce milk which is uniformly very clean.

The element of keeping quality is the one which presents the greatest practical difficulty, because here the responsibility is much divided. Definite information regarding many details is still lacking, but the present stage of knowledge suggests that the most common factor contributing to poor keeping quality is the condition of the milk cans which are supposed to be properly treated at the milk plants. Where milking machines are used, they are very frequently a large contributing factor to the short keeping quality of the milk.

The adoption by the producer of the uniform practice of rinsing his milk utensils with scalding hot water shortly before they are used, would contribute very much to the keeping quality of the milk. In practice each utensil coming into contact with the milk adds to its germ content and decreases its keeping quality. A reduction of the number of such utensils to the minimum is very desirable.

Under ordinary conditions the udder of the cow contributes but a small number of germs and these have little effect upon the milk. Occasionally, however, cows or even herds are found where the udder content is high and the effect upon the keeping quality of the milk pronounced. Further information is necessary before the true significance of this factor can be accurately estimated.

RESPONSIBILITY OF THE DISTRIBUTOR.

The responsibility of the distributor in the matter of food value concerns itself essentially with conserving the food value of the milk as furnished him by the producer. Where economic conditions permit, he is able to stimulate the production of milk with a higher food value by paying a differential price.

For the healthfulness of milk a heavy responsibility lies upon the distributor, particularly when he is charged with its pasteurization as a final safeguard to the consumer. As a possible source of
disease-producing germs, human beings are more dangerous than cows, and a medical supervision of the employees of the milk plant is desirable. This is particularly important in the case of milk pasteurized in bulk, since this process gives no protection from the later contamination, which is a more or less remote possibility during the cooling and bottling processes.

The milk as it comes from the producer usually is and always should be clean. The problem of the distributor is to preserve this cleanliness.

The keeping quality of milk is more largely within the control of the distributor than is usually supposed. He is frequently responsible for the washing and steaming of the milk cans. Where this steaming is done in a perfunctory manner, particularly where tight-fitting covers are applied to wet cans in warm weather, these cans become one of the most important factors in reducing the keeping quality of the milk. Where a proper washing of the cans is followed by a thorough steaming and the cans are carefully dried before being covered, they will have little objectionable effect upon the milk. The large germ content added to milk by utensils within the distributor's plant is frequently an important factor in impairing its keeping quality. The milk coolers and the bottling machines require special watching in this connection, not only because they frequently add large numbers of germs, but especially because they add them after the milk has been pasteurized.

The intelligent application of steam to all of the utensils should be a routine procedure, and the flushing out of all utensils with scalding water shortly before using them is a valuable additional precaution.

**Responsibility of the Consumer.**

The food value of the milk furnished the consumer will depend primarily upon what the consumer desires and is willing to pay for. A considerable proportion of the consumers are desirous of obtaining a milk carrying 4 per cent. of fat or more, and where the milk has been sold regardless of food value they have striven to find the richest milk available at a given price. If each bottle of milk carried a statement of its fat content, the responsibility would then be upon the consumer to recognize and pay for increased food value.
The consumer thru his agents, the health officials, must determine how the healthfulness of the food supply shall be safeguarded. The dangers which naturally surround milk production and handling are such that if the milk supply is to be safe it must be protected either by a medical supervision of the health of the cows and the men or by proper pasteurization, or better, by a combination of both means of protection.

The cleanliness of milk, as it is now delivered to the consumer is in general very satisfactory, but continued emphasis is needed to insure that it shall be constantly maintained at a high level.

The keeping quality of milk is constantly receiving the attention of the consumer, since there is no other shortcoming of milk which is more quickly impressed upon him. The delivery to the consumer of old, stale milk, on the verge of souring, is quite as much a fraud as the delivery of milk deficient in food value, healthfulness, or cleanliness. The consumer is constantly insisting on improvement in keeping quality, and his desires will be met as rapidly as the producer and the distributor find economical means of insuring this improvement.

Since the keeping quality of milk after delivery is dependent primarily upon the temperature at which the milk is held, the responsibility rests upon the consumer to hold the milk at a reasonably low temperature after it is delivered to him. Too frequently little regard is given to this matter by the consumer, and much of the criticism directed against the keeping quality of milk is accordingly unjust.