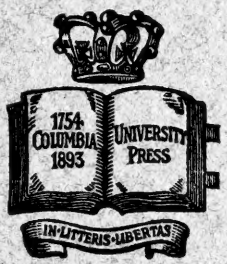
MILK PRODUCTION COST ACCOUNTS

PRINCIPLES AND METHODS

BY
CARL W. LARSON, PH.D.



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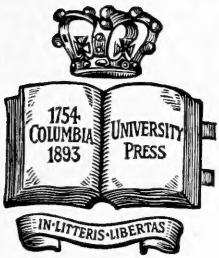

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PREFACE

THE growing interest in the cost of producing milk is largely due to the increase in price during the past few years. State and Federal experts have studied the problem, and Extension and County agricultural workers, city chambers of commerce, special committees appointed by citizens, boards of health, and other municipal organizations and officers are devoting considerable effort to the study of milk cost.

There is considerable unrest in the dairy industry: The producer commonly is not satisfied with the price he receives, the dealer feels that he is receiving no more than his share of the final price for the class of milk and the service demanded by the consumer, and the consumer objects to the increase that from time to time is made in the price of milk. In general, the production and the sale of milk are not on a sound economic basis, and the method of cost computation discussed herein is offered as a step toward establishing sound and equitable conditions. It is hoped that it will at least lead to a standard method that may be used generally and that it may afford opportunity for comparisons. This study only deals with the problem from the standpoint of cost of production, and does not include the subject of distribution, which constitutes a problem of perhaps equal importance.

In the many bulletins and reports extant on the cost of producing milk, no two of them follow the same plan; even different reports from the same experiment station have been worked out under systems that make comparisons impossible. The various writers are not agreed on the relative importance of the different factors involved and the methods of handling them. In this discussion an effort is made to analyze each item of cost and also to apply the methods and practices of recognized authorities in factory cost accounting as far as they may be applied to milk production cost.

The idea of pre-calculating feed costs has, as far as is known, never been suggested before. At first thought it may seem impractical. Nearly all scientific and successful practical feeders of dairy cattle, however, have full confidence in the reverse of the formula recommended herein. On a basis of the reverse of the formula, or with some other standard, they compute the feed requirements of their cows. The value of a method for pre-calculating costs is obvious. Without it milk costs are only history, and when finally computed are not applicable under changed prices of feed. The value of the method suggested herein is that by the use of it cost may be determined at any time. It is only necessary to know the kind and prices of feed. With the systems now in general use the records of milk costs merely show what the cost has been and may not apply when one feed has gone up in price and another down. The author is looking to the ideal condition when we shall be able to figure milk prices as accurately as the modern shop manager who, given the prices of material and labor, can figure to a fraction of a cent the cost of producing certain articles. The formula used herein is based on Armsby [1] Energy Tables and Maintenance Standard, combined with Eckles [2] Milk Standards.

The author is aware of the fact that there is some difference of opinion as to which feeding standard is most nearly accurate, and the standard here used may be changed slightly without seriously affecting the use of the method. Such modification as the user wishes to make or finds desirable may be applied with little change of formula. Even another standard or basis of food requirement may be used. The Feed Unit System with the Scandinavian Feeding Standard may easily be substituted. This system would be even more simple and would no doubt give satisfactory results. The Energy Method is used because it is growing in favor in this country at the present time and has given excellent results in practice.

It is thought the discussion of other items of cost will not only serve the purpose of furnishing a method of cost estima-

[1] U. S. Department of Agriculture, Farmers' Bulletin No. 346.

[2] Missouri Agr. Exp. Sta., Research Bulletin No. 7.

tion, but will show where increases or decreases come about, the effect of increase in the price of labor on final cost, or perhaps where costs may be reduced in one item or another.

The author wishes to acknowledge the helpful advice and criticism of Professor O. S. Morgan. He also is grateful to Helmer Rabild for data on the ages of cows.

CARL W. LARSON.

NEW YORK CITY
March, 1916.

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INTRODUCTION

THE efficiency wave that has gone through our factories in recent years is reaching the farms and dairies of the country. Because of cheap land and the great natural fertility of the soil, because new lands have been opened up almost every year, and because the farmers have been able to succeed without efficient management, they have been the last to make a systematic study of operation and cost of production. Cost determination is essential to efficiency. It not only furnishes a guide to a profitable selling price, but also enables the producer or manager to direct and control the different factors of cost. A complete and properly arranged cost statement enables the dairyman to study and to compare methods and finally to determine by which method milk can be produced most cheaply.

Milk is one of the most important of our agricultural products. There is no substitute for it, and it will always be in demand. Such proper adjustment as will encourage the dairy industry must and will be made. The consumer eventually will pay the producer a reasonable profit. The results of surveys and studies of cost estimates, however, indicate the existence of rather startling conditions. Some of these are so significant that it may be appropriate to quote at some length from the discussions of conclusions made by men who have studied the concrete situation. The most sweeping statement is made by Professor J. B. Lindsey,[1] who, in discussing the results of an experiment covering 15 years, says:

"It is very evident from our own figures and from those derived from other sources that under present conditions it is not satisfactory business to attempt to produce reasonably clean milk under

[1] Massachusetts Agr. Exp. Sta., Bulletin No. 145, pp. 20–21.

the most ordinary conditions for less than 5 to 5½ cents per quart at the farm. In fact, it is doubtful if practical business men would consider it as a business undertaking unless they were able to secure a price per quart for their milk at least 10 to 20 per cent in advance over the cost of production.

"The cost of production naturally would be considerably increased if the producer invests capital in a modern barn and well-equipped dairy house, if his farm is located where taxes or labor is high, if he purchases nearly all of his feed, if he employs a superintendent or charges a reasonable sum for supervision, or if he makes an inspected or certified product.

"Why has the producer received so low a price? It is the belief of the writer that in the past a great deal of milk has been made and sold for less than the cost of production. In making an attempt to gain a temporary livelihood from dairying, many have sacrificed the fertility of their farms, employed the most primitive methods of housing and caring for the dairy stock, while the family have cared for the milk and dairy utensils without credit. The dairyman has forgotten or neglected to estimate his time at a fair value and to take into consideration the cost and depreciation of barn tools, dairy utensils, and such perishable foods and supplies as brushes, salt, soap, ice, bedding, bull service, veterinary services, and the like, all of which are absolutely necessary. In other words, the keeping of accurate accounts and the application of the ordinary business methods have been too often neglected. Such methods on the part of the producer as against the organized business method of the contractor have resulted in a measure at least in the establishing of a relatively low wholesale and retail price.

"Now that health authorities are with right demanding better dairy methods, the producer is indeed confronted with a serious problem, namely, how to conform to modern sanitary requirements in the face of the increased cost of labor, grain and tools and produce milk at a reasonable profit. He is meeting this problem at present in a negative way, by selling his cows and trying to turn his attention to other lines of agricultural industry."

Dr. A. L. Thompson,[1] in discussing the results of his investigations of cost of producing milk on 174 farms in Delaware County, N.Y., is almost as skeptical of the dairy business. He found that:

[1] New York Agr. Exp. Sta. (Cornell), Bulletin No. 364, pp. 140–141.

"There were fifteen herds, or about one herd in eleven, that showed a profit. There were forty-six herds, or about one in four, that produced milk for $2 or less per hundredweight. At the prices of feed, labor, and use of capital figured, the average cow in Delaware County failed by $32.14 to pay expenses. To state the results in another way, the average cow paid all costs excepting the value of hay and forage that was raised on the farm. For this hay and forage the cows paid 28 per cent of its farm value.

"Some farmers keep unprofitable cows for the sake of having manure to use on their land. If the use of this manure is the cheapest means of building up the land, the system is justified, but it is possible for the manure to cost more than it is worth. With the foregoing valuations for labor, feed, and use of capital, in order to have prevented a loss on the dairy enterprise in 1912 manure would have had to be worth $6.85 per ton in the barn. The crops generally grown in the County — corn, oats, millet, and hay — do not justify paying such high prices for manure. . . .

"The question might be asked, how do these farmers live when they sell hay to cows at a lower figure than its farm value, or when they work for lower wages than the rates indicated, or when they accept a lower rate of interest than 5 per cent. The dairymen of Delaware County are doing one or more of these things."

Although the author does not agree fully with these conclusions, they emphasize in a forceful way the importance of a thorough study of the whole subject and especially the need for a uniform basis and a correct and fair method of cost accounting so that the industry may be placed on a sound economic plane. Although as a rule little study is made of costs on the farms of the United States, still adjustment does take place. As soon as the price of milk becomes a little greater than the cost of production, land and cattle advance in price. The adjustment is not always immediate, but when net returns of the farms or bank accounts show that the industry is profitable in some cases, others extend their farm operations to include dairying.

In pointing out some of the items of cost that it is thought other writers should not have included, the author is not doing so for the purpose of defending the consumer and some dealers who attempt to keep the price down, but if possible

to determine a fair and definite method of cost accounting that will be generally accepted. The different items are discussed separately.

A cost method is important to the individual producer in showing whether his dairy is profitable, whether some operation costs more one year than another, and possibly in suggesting some means of producing milk more cheaply. A definite and correct system, used as a standard, should make it possible to compare costs in different sections of the country, and eventually to determine a price that will be fair and reasonable to the producer and at the same time satisfy the consumer that he is paying only what is equitable for the capital, labor, and other expense necessary to produce milk. Rough estimates and errors have the opposite effect.

Although in a great many localities surveys show an actual loss in dairying when all costs are included, still the dairymen usually are successful farmers, and dairy sections and dairy communities are almost without exception prosperous. This, of course, may be difficult for the consumer to understand. Dairymen who are making a special product and getting a special price for it are in most cases satisfied, but in those communities where conditions show the dairy industry to be unprofitable, there are several reasons why dairymen continue in the business:

1. On account of changed conditions some are producing milk at no profit or at a loss. An improved method of shipping milk may be a factor in this. A dairyman who lives near a city is able to sell his straw, stover, and other feeds at a higher price, and perhaps also his labor is high priced. With improved facilities of transportation he is obliged to compete with a farmer who occupies cheaper land and who places low values on his coarse feeds.

2. There are those who are satisfied to produce milk at actual cost in order that they may get some return for labor that they could not use without the dairy. To illustrate — assume that there are two farmers, each with 160 acres of equally good land, one having 10 cows and the other none. Now we may suppose that the farmer with the 10 cows sells

his milk at exactly the price that careful and accurate records show it to cost. Figuring roughly that labor was charged at $30 per cow per year, the farmer with 10 cows would then have $300 more than his neighbor at the end of the year, for he would spend no more for his labor. In the summer his children are at home and do the milking, and during the winter it can be done by the farmer himself. He is therefore $300 better off at the end of the year than his neighbor. Some contend that this is a division of labor, others that it has nothing to do with the actual cost of milk. It is nevertheless one of the important reasons why some dairy farmers are apparently more prosperous than those on similar farms and without cows.

3. Some dairymen have land which can not be used for anything except pasture, or have stover or inferior hay and other feeds that can be utilized for milk production, but that could not well be marketed.

4. There are those who found the milk business profitable when feed, labor, and other expenses were cheaper, and although their price for the product may not have advanced in the same proportion as cost, still they continue in the industry in the hope that they will eventually get a higher price for the milk.

5. With some farmers a few cows fit in well with the general farm scheme. To this class belong those who have a little pasture, those who want a certain quantity of manure for a particular crop, and those who want a certain small cash income throughout the year. It is the farmers with small herds, more than any others, who produce the bulk of the milk of this country, and keep the price low.

The above reasons are not given to justify low prices of milk, but rather to explain why some are producing milk although when all actual costs are counted the business does not show a profit.

MILK PRODUCTION COST ACCOUNTS

CHAPTER I

THE FUNCTIONS OF A COST SYSTEM

A cost system has for its object not only a direct benefit to the particular dairyman who keeps accurate cost accounts, but also an indirect benefit to the public by making it possible to put the dairy business on a sound basis throughout the country.

The ends to be attained by a system of cost accounts for milk production are:

1. To regulate selling price.
2. To detect, locate, and eliminate waste in material, labor, and other expenses incident to production.
3. To change any operation and determine the actual effect on cost.
4. To enable the manager to direct the work with greater efficiency.
5. To make it possible to standardize the work.
6. To compute costs at different times and under different conditions.
7. To provide reliable statistics for comparisons and studies in different States and localities.

Almost every dairy in the United States is a part of a general farm proposition, and without cost accounts for the dairy itself it is impossible to determine to which enterprise profits or losses are due. Although a dairy farmer may be getting a fair interest on his capital and a fair wage for his labor, surveys or cost records of his dairy often show that the profits are not derived from the cows. When the feeds are figured

at prices at which they could be disposed of and the labor is actual extra labor that must be paid for, it would of course prove that profits are derived from the farm rather than from the herd. This should prompt the dairyman to be more careful in his cost estimates and endeavor to learn where his various items of cost are higher than they should be, or higher than formerly, and to look for a remedy. It may be that a different ration would be less expensive, perhaps fewer or more cows should be kept or perhaps the cows are poor producers. The cows may be kept on too expensive pasture, or not pastured enough; perhaps the farmer could buy cows cheaper than he can raise them, perhaps he keeps calves too long or he may be vealing calves at a loss. Where the feed prices are figured on a basis of sale or market price or the price at which they could be purchased in the community, it may be found that it would be more profitable to market the crops in the raw state instead of through the dairy. Labor also in some localities makes it unprofitable to produce milk. Again, many dairies are over-capitalized.

These are only suggestions of some of the factors which may not be known unless cost accounts are kept. The efficiency of individual cows is, of course, of great importance; cows of the same size require about the same feed for maintenance,[1] so that a cow that produces 6,000 pounds of milk annually produces it more cheaply per pound than a cow of equal weight that produces 3,000 pounds.

The production cost will be discussed under three main divisions, the feed expense, expense for labor, and indirect expense, the "overhead," or indirect expense being further subdivided. The following outline indicates the method of treatment:

1. Feed.
2. Labor.
3. Indirect expense, or overhead.
    a. Buildings.
    b. Cattle.
    c. Bedding.

[1] "A Study of the Cause of Wide Variation in Milk Production by Dairy Cows," Ekles, University of Missouri, Research Bulletin No. 2, p. 146.

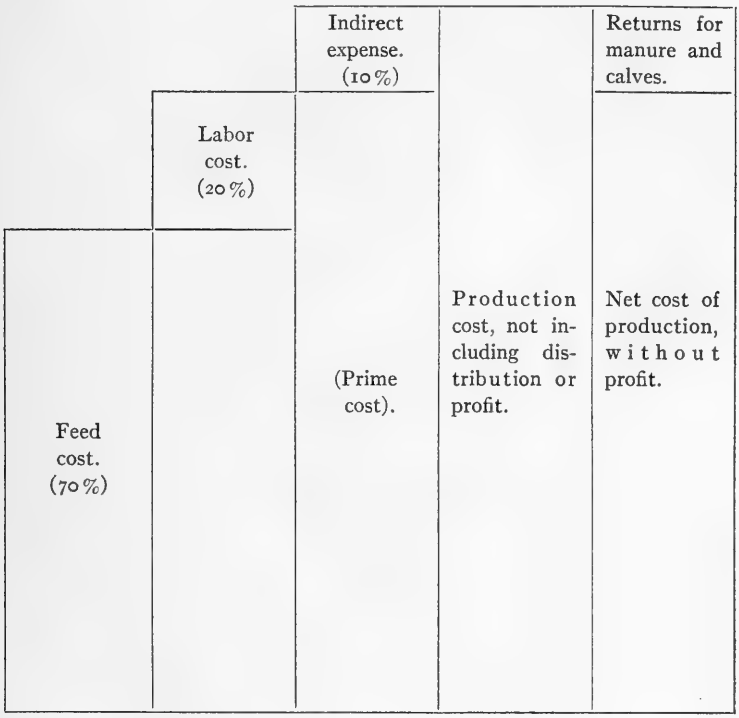
d. Sire.

e. Miscellaneous.

The credit items which should be deducted as special credits in order to determine the net cost of production are as follows:

1. Calves.
2. Manure.

The diagram below is given to show the relation of cost items to net cost of production, under certain conditions. The feed and labor costs are spoken of as prime costs, and they constitute about 90 per cent of the total cost of production.



This diagram is given simply to show the cost factors and approximately their relative proportions to the total cost under particular prices and conditions, and although it represents actual conditions in some sections at the present time, it is

not the purpose here to show average conditions. Instead of attempting to give any average cost, the author wishes to emphasize the fact that costs vary greatly and are determined by certain definite conditions. It is no more reasonable to say that it costs five cents to produce a quart of milk than to say that it costs five cents to make a box. The manufacturer of boxes before stating a price asks the size of the box, the kind of material to be used, whether the sides are to be planed, whether the box is to be made and used in the lumber and mill region of Washington State or in New York City, and also whether 10 boxes are to be made in spare time or 10,000 made at once. Likewise the milk producer should ask in quoting or estimating a price whether it is for 3 or 5 per cent butterfat milk, whether it is to be produced from tuberculin-tested cows and in clean barns by clean labor working under clean methods or by any cows and without particular care in production, whether it is to be produced where hay is worth $10 per ton or $20 and grain $25 or $35, whether conditions are such that the cows must be kept in the stable all or nearly all the year for lack of pasture or whether they can feed on grass six or more months of the year, and perhaps on land unfit for other crops. It should also be known whether it is a price for a small quantity produced as a side line or for a large quantity produced as a specialty. It is to get at these very items of cost, etc., that a cost system is needed.

The above diagram applies where an intensive feeding system is practiced — that is, where considerable grain is included in the ration. Where summer dairying is the practice and where roughage forms a large part of the feed the proportion of labor and indirect cost of production would be greater. Also, in regions where intensive systems are practiced and a soiling system is followed the feed may cost less and labor more. Expensive cattle and buildings increase the proportion of indirect cost. The over-capitalized dairies are shown by the amount of overhead cost. Some cows are bought at such high prices and housed in expensive buildings that no system of feeding, no possible production, and no reasonable price for the milk could make them profitable.

There is even greater direct benefit from keeping records of costs in milk production than in other lines. The most important records and the ones that require most time to keep are absolutely necessary to intelligent feeding. It is necessary for a feeder of milch cows to know just how much each cow consumes and how much milk results. He must have a record of previous days. Records of the weight of the milk together with the weight of feeds make accurate and efficient feeding possible. The statement that one can no more feed a cow intelligently without a record of production each day and of the weight of feed than a fireman can attend a boiler without a steam gauge is true. It is economy to increase coal if the boiler responds with sufficient increase of steam power, but there is danger if too much coal is used. With a cow it is profitable to increase the feed as long as she responds with a sufficient increase in milk, but there is danger of over feeding and "throwing the cow off feed." The most profitable production of a cow is only secured by intelligent feeding and a careful study of the milk and feed records, and it is these records that form a large part of those necessary in milk cost accounting.

The amount of time required to keep these records is slight. A milk scales near the milk tank, and a simple chart with the cows' names or numbers and blanks for the different days are all that is needed for the milk records, and the same scales and a very similar feed chart can be attached to the feed bin or cart for keeping a record of the quantity of feed used. The other items of cost can be kept with even less labor. An occasional weighing of the bedding, simple labor records, and records of expenditures for special apparatus cover the other chief factors of cost that require definite and special accounts. These data can be calculated with little trouble.

The standards given are offered only as a guide, and although local conditions may, for example, make it possible to bed the cows more cheaply with sawdust than with shavings or straw, the relative amounts given will apply, and when other material is substituted in the formula the actual cost may still be given.

CHAPTER II

THE COST OF FEED

The largest and most important item of cost is the feed. This varies greatly with different cows and with different methods of feeding. The kinds of feed used, the amounts consumed, and the cost have a marked influence on the total cost of producing milk.

One of the first questions met with is whether feed should be charged at cost of production or at market price, the market price, of course, being considered as the price at which it could be purchased. There is considerable difference of opinion as to which cost should be used. Hawkins [1] in discussing this from the factory standpoint sums up his conclusions as follows:

"The advocates of cost price claim that by means of it they show the actual cost of manufacture and not what might have been the cost, and that it does not interfere with the balancing of the stores accounts in money value. Those who uphold market price claim that it furnishes a sounder basis for estimating and for competitive purposes by dealing with actual value rather than with former value, and that it rightly causes the effect of fluctuations to be seen in the stores accounts rather than in the job accounts, so that profits or losses due to chance or speculation are distinguished, as they should be, from ordinary trading results."

In the production of milk it is a question whether the cost of producing the feeds on the farm or the price they could be sold for on the market should form the basis of cost calculation. Unless the latter is used as the basis, the dairy cost accounts may be lost in the profits or losses in the farm operations. If the cost of production price is assumed a difference in cost of milk production may be more influenced by the cost of production of the feeds than any other factor, and besides

[1] "Cost Accounts," L. W. Hawkins, p. 78.

it is the profit of the dairy that is directly the result and purpose of these accounts. Also, if based on cost of production there is no profit for the work one puts in the production of these feeds. If the production cost of feeds is high on a particular farm it is reflected in the dairy accounts, and if by efficient management of the farm the feeds are produced cheaply, then the dairy receives undue credit. Pouli [1] in his studies of milk cost in Switzerland says:

"By the introduction of the market price we want to exclude the effect of variation of production cost . . . so as to arrive at conclusions applicable to the general and average cost on the individual farm, we have then seemingly objective, but in reality also varying estimates of prices, which can lead to the above variation of prices. If we add to this the deviation of other expenses, then we get varying conclusions of average cost, although the price rate will correspond to the local or temporary circumstances, in the estimates of the cost of milk production."

When the dairy is considered separately from the farm, there is no doubt that it should be charged with feeds at market prices, but when the dairy farm is small or where the dairy is distinctively a necessary part of the whole farm scheme, then perhaps the cost price could be used. In an interview with Mr. Nicholson, an authority on cost accounting,[2] he stated that it was his practice in large plants that have several departments to charge material from one to another at market price, but with small plants actual cost of materials is used.

In figuring feed costs there are several important points to keep in mind; the following will be discussed:

1. The proportion of roughages or coarse feeds.
2. The amounts of roughage.
3. A balanced ration.
4. Amount of pasture.
5. Feed for maintenance.
6. The quantity and quality of milk produced.

[1] Produktionskostenberechungen, Archiv für Exakte Wertschaftsforschung, Erg. 7.

[2] "Cost Accounting, Theory and Practice," J. L. Nicholson.

Methods of feeding and balancing rations are not discussed, except in so far as is necessary for an intelligent use of the formula or method of pre-calculating costs of feed.

The amount of roughage that a cow will eat depends largely upon the kinds used and upon the size of the cow, also to some extent upon the amount of other feeds or grain used. Some cows are fed little grain, and must depend almost entirely upon roughage for maintenance and milk. Such cows can not produce a maximum for a long period, especially if they have the ability to produce large quantities of milk. When good silage and alfalfa hay are fed fairly large yields may be secured. Good silage contains considerable corn, but careful feeders have found it advantageous to add some grain to the above ration. As a guide in computing roughage, the following rule is offered: To determine how much hay to feed, multiply the weight of the cow in hundreds of pounds by 0.6 and it will give the amount in pounds of hay. For example, a 1,000-pound cow equals 10 hundred pounds, so that following the rule 10 would be multiplied by 0.6, giving 6 pounds of hay. To calculate the silage to feed, multiply the weight of the cow in hundreds of pounds by 2.5. A 1,000-pound cow then would be fed 25 pounds, and a 1,200-pound cow 30 pounds, etc.

Of all the items of cost, the pasture is most important, though it has little mention in most previous writings on cost records. Its importance is pointed out by Cooper,[1] however, who says:

"The importance of pasture in the economy of the farm is illustrated by the small quantity of grain or roughage fed during the pastural season . . . for practically 5 months out of each year the cattle were supported almost entirely from the grass crop."

Warren [2] says:

"Pastures furnish our cheapest feed. The pasture of one cow one day costs 3 to 6 cents, hay or hay and silage 12 to 15 cents, grain 12 to 15 cents. A good pasture will replace all of the hay

[1] Minn. Agr. Exp. Sta., Bull. No. 124, p. 97.
[2] N. Y. Agr. Exp. Sta. (Cornell), Bull. No. 280, p. 355.

and much of the grain. Pasture produces more milk than other feed at one-fifth to one-tenth of the cost."

The amount charged for pasture varies with different investigators, as for example Hooper and Robertson [1] suggest $1 to $1.50 per month, Rasmussen [2] 25 cents to $1 per month, Lindsey [3] 5 cents per day, Thompson [4] $4.29 per cow and accompanying stock for the season, and Woll [5] $5 per season. At these prices the cost while on pasture is very much cheaper than if the cows were fed in any other way. It shows, however, how important a factor the pasture is in calculating feed costs and the importance of indicating in cost records the part of the feed secured from pasture. Tables given by Woll on pages 71 and 74 show how valuable pasture is to a dairyman when it costs no more than $5 per season, as he has estimated. The best Holsteins secured 1,153 feed units, or one-eighth of all the feed units consumed from grass, while the best Jerseys secured 1,506 units, or one-fourth. The total cost of feed for the former was $99.23, and for the latter $80.06, and the pasture furnished one-eighth of the units for the Holsteins and one-fourth for the Jerseys at a cost of only $5. Good pasture will supply 10 feed units per day,[6] and a unit is based upon the equivalent in feeding value of a pound of corn. When corn, therefore, is worth 1 cent per pound a dairyman can afford to pay 10 cents per day, or $3 per month for good pasture rather than feed his cows in the barn on feed of equal cost. It should be said, however, that a high-producing cow can not get enough feed from pasture to keep up her flow and maintain her weight. When pasture is charged at a definite price per month or season the economy of production favors the smaller producer. Cows giving large amounts of milk need some concentrated feeds in addition to pasture.

In pre-calculating costs, therefore, the amount of time on pasture must be determined, and the time the cows are on

[1] N.Y. Agr. Exp. Sta. (Cornell), Bull. No. 357, p. 140.
[2] New Hamp. Agr. Exp. Sta., Ext. Bull. No. 2, p. 4.
[3] Mass. Agr. Exp. Sta., Bull. No. 145, p. 9.
[4] N.Y. Agr. Exp. Sta. (Cornell), Bull. No. 364, p. 216.
[5] Wisc. Agr. Exp. Sta., Research Bull. No. 26, p. 58.
[6] Wisc. Agr. Exp. Sta., Circular No. 37, p. 6.

pasture will depend, of course, upon the kind of pasture available, location, and season.

The next step is to arrive at a correct charge for the pasture. It has been customary in the past to use the figure for prevailing charge in community or simply a definite estimated amount. Thompson,[1] however, bases the cost, with no profit from land, as follows:

"Interest amounting to 5 per cent and taxes amounting to 0.5 per cent were charged on the actual value of the land in pasture. To these amounts were added all other costs, such as making and repairing fences, manuring, fertilizing, reseeding, mowing, and the like. The average value per acre was $19.41. The annual cost of this pasture was . . . $4.29 per cow and accompanying stock."

With the accompanying stock deducted, the cost would have been approximately $3.50 for the season. The interest on the land was about three-fourths of the total cost, so that if high priced land were used the cost would be increased. This seems to be a satisfactory method for permanent pastures that can not be tilled, or land that for some other reason must be kept in permanent pasture. With land, however, that can be farmed a better method is to charge pasture at the rate per acre that it would return in hay, less the cost of making, storing, and marketing. The fairness of this method was pointed out by the great economist Adam Smith[2] more than 150 years ago. He said:

"A great part of the cultivated lands must be employed in rearing and fattening cattle, of which the price, therefore, must be sufficient to pay not only the labor necessary for tending them, but the rent which the landlord and the profit which the farmer could have drawn from such land employed in tillage."

In establishing a cost for pasture the steps are (1) to reduce the pasture to a unit basis, that is, the number of acres needed per cow, and the months that a cow can be fed on such pasture, (2) to estimate the land rental, which should be charged

[1] New York Agr. Exp. Sta. (Cornell), Bull. No. 364, p. 126.

[2] "Select Chapters and Passages from The Wealth of Nations," Adam Smith, p. 133.

on the basis of a legitimate interest on the value of the land. Five per cent is the basis used throughout this paper. All authorities do not agree that interest, or rent, should be charged on land that is owned. If interest were not charged on owned land, it would be better for the farmer to have his money invested in good bonds which would return dividends and pay interest on a farm mortgage, and to include this interest in the farm cost, or rent. The interest must be borne by the owner of the land in some way, so that if it is not included in the cost, it must be deducted from the profit, (3) to estimate the general expense, which includes taxes, making and repairing fences, seeding or reseeding, and fertilizing. Pasturage, therefore, would be computed as follows:

1. Value per acre multiplied by 5 per cent, which may be considered as rent.

2. General expense, which on the average will be about $1 per acre.[1]

3. Acres required per cow per season, or estimated on the basis of cost per cow per month.

The formula for pasture cost where land is worth $50 per acre and would pasture one cow on two acres for 5 months would be as follows:

Rent	$2.50
General expense	1.00
Cost per acre	$3.50
Two acres per cow	$7.00

The cost of pasture for the season would be $7, or, on a basis of 5 months, $1.40 per month.

Now having determined the items of roughage and pasture which have such an important effect upon the cost of production, the grain ration must be considered. This in turn is dependent upon the size of the cow, and has a direct relation to the quantity and quality of milk produced.

The idea of the pre-calculated cost accounts for milk probably will be accepted without question except in the part that

[1] N.Y. Agr. Exp. Sta. (Cornell), Bull. No. 364, p. 126; computed from Table V.

undertakes to determine the feed costs. The feed cost is based on scientific feed-requirement standards, and it is assumed that, given the size of the cow and the amount and quality of milk produced, the amount of protein and energy necessary to maintain the cow and supply enough of energy and protein for the milk can be accurately determined. The first question naturally asked is, are all cows equally efficient? They are not, because not all produce the same amount of milk, but those that produce the same quantity are practically equal in efficiency. Stating this in another way, a cow of a certain size requires for maintenance practically the same amount of feed as any other cow of the same size, and the amount of food required per unit quantity of same quality of milk is practically the same. The following are selected quotations from Eckles and Reed [1] in a careful study in milk production, and indicate their conclusions from digestion trial:

"The digestion trial showed practically identical results."

"The real cause of the difference in production was found to be in the amount of feed consumed above maintenance."

"After deducting the maintenance required one cow produced milk as economically as the other."

"The main difference between profitable and unprofitable dairy cows is not to be found in the coefficient of digestion, or in the amount of food required for maintenance."

"The superior dairy cow is simply one with a larger capacity for using food above the maintainence requirement and one that uses this available food for milk production."

It is obvious from these conclusions that of two cows of the same size the one that will produce the greater amount of milk is the more profitable, for the feed required for maintenance is practically the same. Two cows, each producing 10 pounds of milk per day, produce it at a greater cost than one of the same size that produces 20 pounds. This is important in figuring feed costs.

When it is agreed that we have feeding standards that can be relied upon for determining the requirements of cows, it is certainly reasonable to use them in calculating feed costs.

[1] Missouri Agr. Exp. Sta. Research Bull. No. 2, p. 146.

In this connection, however, it must be kept in mind that the calculations are based upon the cows keeping a constant weight. If the practice is to underfeed the cows during the winter, depending upon the stored-up energy accumulated by the cows while on pasture, less feed might be given with a return in milk greater than the feed given would supply. This practice is followed by many dairymen, and an allowance must be made when this is done. That is primarily summer dairying; the data which follow are based upon a year-round production.

The writer has applied the following method to a number of actual cost calculations of feed required and the results are remarkably near the actual — as near no doubt as the actual weight records could be kept in a practical way.

The difficulty in applying this method to actual records that have been published, except in a very few instances, is that the amount of food secured from pasture has not been stated. A definite price charged for pasture and the actual amounts of the feed are given, but unless it is known what amount of the total feed was furnished by the pasture, the results can not be checked. It is important that cost records give the returns from pasture, or the time the cows were supplied by the pasture. Under some circumstances and conditions the pasture would furnish an even greater part of the feed for the year than is suggested by Woll in the work referred to above.

Before applying the formula for feed cost it will be necessary to give the material upon which it is based. This may be presented in three tables, as follows:

TABLE I. MAINTENANCE REQUIREMENT FOR COWS.[1]

	Pounds digestible protein.	Therms net energy.
500-pound cow requires for maintenance.....	.3	3.80
750-pound cow requires for maintenance.....	.4	4.95
1,000-pound cow requires for maintenance.....	.5	6.00
1,250-pound cow requires for maintenance.....	.6	7.00
1,500-pound cow requires for maintenance.....	.65	7.90

[1] Farmers' Bull. No. 346, U. S. Dept. of Agr., p. 16.

TABLE II. REQUIREMENT FOR MILK OF VARYING RICHNESS.[1]

Per cent.	Digestible protein per pound of milk	Therms energy.
3.00	.050	.26
3.50	.052	.28
4.00	.055	.30
4.50	.058	.33
5.00	.062	.36
5.50	.066	.40
6.00	.070	.45
6.50	.075	.50

The following may be used when individual production is not known:

	Digestible protein.	Therms energy.
Holsteins	.05	.26–.28
Shorthorns	.055	.28–.30
Ayrshires	.055	.28–.30
Brown Swiss	.055	.28–.30
Jerseys	.066	.40–.45
Guernseys	.066	.40–.45

TABLE III. FOR THE EXACT CALCULATION OF INDIVIDUAL RATIONS.[2]

Digestible protein, and energy values per 100 pounds.

Feeding stuff.	Digestible true protein. (pounds)	Energy value. (therms)
Green fodder and silage:		
Alfalfa	2.50	12.45
Clover — crimson	2.19	11.30
Clover — red	2.21	16.17
Corn fodder — green	.41	12.44
Corn silage	0.88	16.56
Hungarian grass	1.33	14.76
Rape	2.16	11.43
Rye	1.44	11.63
Timothy	1.04	19.08
Hay and dry coarse fodders:		
Alfalfa hay	6.93	34.41
Clover hay — red	5.41	34.74

[1] "Nutrients required for Milk Production," Univ. of Mo., Research Bull. No. 7, p. 138.

[2] Pa. Exp. Sta., Bull. 111, p. 15, and Farmers' Bull. 346, p. 15.

Hay and dry coarse fodders — *Continued*		
Corn forage — field cured	2.13	30.53
Corn stover	1.80	26.53
Cowpea hay	8.57	40.76
Hungarian hay	3.00	44.03
Oat hay	2.59	26.97
Soy bean hay	7.68	38.65
Timothy hay	2.05	33.56
Straws:		
Oat straw	1.09	21.21
Rye straw	.63	20.87
Wheat straw	.37	16.56
Roots and tubers:		
Carrots	.37	7.82
Mangelwurzels	.14	4.62
Potatoes	.45	18.05
Rutabagas	.38	8.00
Turnips	.22	5.74
Grains:		
Barley	8.37	80.75
Corn	6.79	88.84
Corn-and-cob meal	5.53	72.05
Oats	8.36	66.27
Pea meal	16.77	71.75
Rye	8.12	81.72
Wheat	8.90	82.63
By-products:		
Brewers' grains — dried	19.04	60.01
Brewers' grains — wet	3.81	14.82
Buckwheat middlings	22.34	75.92
Cottonseed meal	35.15	84.20
Distillers' grains — dried		
Principally corn	21.93	79.23
Principally rye	10.38	60.93
Gluten feed — dry	19.95	79.32
Gluten meal — Buffalo	25.56	88.80
Gluten meal — Chicago	33.09	78.49
Linseed meal — old process	27.54	78.92
Linseed meal — new process	29.26	74.67
Malt sprouts	12.36	46.33
Rye bran	11.35	56.65
Sugar-beet pulp — fresh	.63	7.77
Sugar-beet pulp — dried	6.80	60.10
Wheat bran	10.21	48.23
Wheat middlings	12.79	77.65

To illustrate the application of this method, certain conditions may be assumed: suppose that we have a herd of Guernsey cows which average 1,000 pounds in weight, that give on an average 8,500 pounds of milk per year, and that the milk contains 5 per cent of butter-fat.[1] The first step is to calculate the amount of protein and energy required by the cows. Assume that 20 per cent of the year's feed is secured from pasture. The cows will no doubt be on pasture more than 20 per cent of the days in the year, but secure some other feed a part or all of the time they are on pasture. We have then to provide feed for 280 days. By referring to Tables I and II we determine the following needs for cows of this sort:

	Protein.	Energy.
Maintenance.....	.5 × 280 = 140	6 × 280 = 1,680
8,500 pounds 5 per cent milk....	.062 × 8,500 = 467	36 × 8,500 = 3,060
Total amounts needed.....	607	4,740

The cows must be supplied with 607 pounds of digestible protein and 4,740 therms of net energy. Now let us assume that we are feeding silage and clover hay for roughage. Referring to the formula suggested above, we find that a 1,000-pound cow would consume 6 pounds of hay and 25 pounds of silage, or 1,680 pounds of hay and 7,000 pounds of silage for the 280 days. By referring to Table III we find that 1,680 pounds of red clover hay supplies 90.89 pounds of the digestible protein and 583.63 therms of net energy. In like manner the protein and energy supplied by the silage can be computed.

	Pounds protein.	Therms energy,
Amount needed.....	607.00	4,740.00
Supplied by hay...90.89		583.63
Supplied by silage. 61.60		1,159.20
Total.....	152.49	1,742.83
To be supplied by grain	454.51	2,997.17

Now by turning to Table III we can select a ration that has a ratio of protein to energy equal to that of the part to

[1] "Studies in Milk Production," Woll, Wisc. Exp. Sta., Research Bull. No. 26, p. 74; figures from actual records of cows in contest.

be supplied by grain, which is about 1:6.5. Such a mixture is supplied by the following ration:

	Protein.	Energy.
150 pounds corn or hominy	10.5	132
100 pounds distillers' grains	22	79
100 pounds bran	10	48
100 pounds oats	8	66
450	50.5	325

This ration supplies 50.5 pounds of protein and 325 therms of energy. By dividing 454.51, the amount of protein needed, by 50.5 we get the amount of this mixture needed for the year, or nine. Expressed in another way, each cow of the size and production indicated would require besides the hay and silage 9 times each of the different quantities of feeds used in the above mixture. These feeds would not furnish the cheapest ration at the present time, but are the ones commonly used by the dairymen from whom Woll gathered his data. The size and production of the cows assumed here are also the averages for the Guernseys in these studies, and the prices here assumed are the same as those used by Woll.

To summarize the feed cost, we have the following:

1,680 pounds of hay at $0.80 per 100	$13.44
7,000 pounds of silage at $0.15 per 100	10.50
1,350 pounds of corn at $1.00 per 100	13.50
900 pounds of distillers' grains at $1.50 per 100	13.50
900 pounds of bran at $1.05 per 100	9.45
900 pounds of oats at $1.10 per 100	9.90
Pasture for season at $5.00	5.00
Total cost of feed for year	$75.29

The average cost of feed per year for 157 cows included in the studies by Woll was for Guernsey cows of this class $70.95. These cows averaged 8,500 pounds of milk, so the two results differ by less than one-fifth cent per quart. Some of the rations contained less distillers' grains, making a cheaper ration, and some cows got more than 20 per cent of their total food from pasture, both of which tends to reduce the average cost. Others got some stover and straw.

This method requires considerable space for discussion, but

it can be calculated quickly and easily, and can be applied to any system of feeding. The accuracy of the method can not be questioned, and it will not only simplify cost estimates, but make them applicable under definite conditions at any time. A further benefit from its use is that the advantages and disadvantages of different systems may be studied. Generally it is not definitely known how valuable pasture really is, and in some cases it is not considered economical to pasture cows at all. A glance at the summary of feed costs on page 29 will show that although pasture was charged at $5 for the season, still Woll's figures indicate that the Guernsey cows in the contests derived from 16.2 to 20.9 per cent of their total feed units for the year from pasture. It is obvious that the pasture was really worth several times $5.

As a further suggestion of the value of pre-calculated feed costs, we find by referring to the Bulletin by Woll[1] that in comparing the different breeds of cows, for the best 25 Holsteins the ratio of cost of feed to net returns was 100:107, while for the best Jerseys the ratio was 100:143. The pasture was charged at $5 per season, but on page 74 of Woll's publication the 25 best Holsteins are shown to have received 12.8 per cent of their feed units from pasture, while the Jerseys secured 25.4 per cent and at the same charge. This is simply cited as an instance where such a method as is suggested can be used in calculating feed costs, and in showing the advantages or disadvantages of different systems.

Although in general it is well to have high production to counterbalance the cost of maintenance, the last few pounds of production of many cows cost too much. Often by feeding less grain and not attempting to force to the very limit a cow will produce somewhat less milk, but the total amount of milk secured will be produced at proportionately less cost. A cost calculation month by month will show when the cows are most profitable and how expensive they are, or even how much the profits of some months are consumed by expensive or forced feeding during other months.

[1] "Studies in Dairy Production," Wisc. Exp. Sta., Research Bull. No. 26, p. 72.

CHAPTER III

THE COST OF LABOR

LABOR, although not the largest item of cost, is of considerable importance in dairy herd management. It is of peculiar interest because of its various phases and effects upon the dairy industry. Some dairymen claim to have been driven out of the business because of the difficulty of getting men to work on farms where cows are kept, while others continue in the business because it furnishes employment to regular help at times when the men could not be used otherwise, although it may not pay in full for the labor.

There is difficulty in securing good labor on dairy farms when the men are expected to milk a few cows before breakfast, then do a day's work in the field, and return to milk the cows again in the evening. Where the milking is considered an essential part of the day's work there is no more difficulty in getting good men on a dairy farm than on any other kind of farm. On large dairy farms where the hours are definite and the work is regular, practically no trouble is found in getting and keeping good men. On the small farms the labor is performed with no extra cost and in addition to the work in the field. When cost records on these farms show that the milk is produced at a loss, it simply means that labor is performed at a lower wage than the figure used in the cost account. Often, however, the farmer is willing to do the work for the increase in income, although it is less than a good wage. Also the women and children do the milking and care for the cows in some cases; on some farms the children are home from school and can help with the dairying during the busy season. Women and children usually are better milkers than men, because their hands and muscles are not so hard. The use of child labor on the farm is not to be compared with

its use in the factory, for on the farm the children work with their parents and under conditions that are helpful. The dairy furnishes a good medium for using the children on the farm. It may not, however, be out of place here to say that the dairy farms more than any other are driving the boys to the cities. Poor cows, poor barns, and the milking as extra work discourage boys from remaining on the farm. On the other hand, when good cows are kept, in convenient, comfortable barns and when caring for them is considered a part of the day's work, or better still where the time is spent solely in caring for cows, the work in the dairy is not objectionable to most boys.

The labor cost does not vary so much on different farms as does the feed cost, assuming that milk of equal quality is produced. The system of management and the number of cows kept are important factors. Where the labor is paid for and used in caring for cows when it could be used otherwise, it costs less for labor to increase the number of cows up to a point where one man would devote all his time to the dairy. There would be less time lost, the man would be better satisfied, and the cattle better cared for. On the other hand, it often develops that when the caring for the cows is done on extra time or by women and children, and when the herd is increased so much that the producer must hire extra labor for the dairy, he often finds the business less profitable. This in a large measure is the reason some dairymen who are producing milk from large herds find it difficult to compete with the smaller producer on a basis of the same grade of milk. Some dairymen succeed with the larger herd by turning to the production of a higher grade of milk, for which they demand a higher price.

From the standpoint of actual time required per cow and the efficiency of labor, the larger dairy is to be preferred. The man who devotes all his time to the cows can give them better care and lose less time. On dairy farms where men do work in the fields much time is lost in changing from one job to another, and a man can not do as good work in the barn when he also does heavy work in the field.

It is the practice of some in figuring milk cost to conclude that the manure offsets the cost of labor. This may not be far from correct on farms where summer dairying is practiced and the cows are allowed to go dry in the fall and gather their winter maintenance from corn fields and straw stacks. Sheppard and Richards [1] in their cost estimates state that:

"Only the cost of feed is included in the cost of production. The value of manure is taken as offsetting the cost of labor, as is customary to do in preparing estimates of this kind. If the cows were credited with the value of the manure, it would no doubt offset the cost of labor required to care for the herd."

With winter feeding and care, and especially where clean milk is produced the manure is not worth the cost of labor.

The number of cows in the herd is a factor to consider. Certain operations take about the same time whether many or few cows are kept. In general, it takes five times as long to milk five cows as one, but twenty cows can be fed or brought from the pasture in about the same time as five. The amount of milk a cow gives is also important, for it requires no more, or only a little more time to milk a cow that gives a large quantity than one that produces less.

The cost of labor required to care for a cow a year is given by various authors as follows: Truman [2] $33.60, Minkler [3] one man for twelve cows, at $1.50 per day, or $43 per cow per year, Rasmussen [4] $22.33; on specialized dairy farms each man takes care of fifteen cows, or $36 per cow per year. Hooper and Robertson [5] estimate the cost at $23.12 per cow, or 154.5 hours a year, or 25.4 minutes per cow per day. Thompson [6] states that on dairies studied, 155 hours of labor were required to care for each cow and accompanying stock in herds of twenty or less cows, and 107 hours in herds with more than forty cows; the cost was $18.11. Johnson and Ford [7] state

[1] "Dairy herd records," No. Dak. Agr. Exp. Sta., Bull. No. 91, p. 153.
[2] Storrs Conn. Exp. Sta., Bull. No. 73, p. 130.
[3] New Jersey Exp. Sta., Report, 1909, p. 165.
[4] New Hampshire Exp. Sta. Ext., Bull. No. 2, p. 9.
[5] New York Exp. Sta. (Cornell), Bull. No. 357, p. 153.
[6] *Ibid.*, Bull. No. 364, pp. 147 and 140.
[7] Missouri Agr. Exp. Sta., Bull. No. 125, p. 310.

the average cost of labor on certain Missouri farms was $24.60 per year per cow. Warren [1] concludes that in well-managed dairies 150 hours are required per year per cow, and that in a study of labor cost it is necessary to decide the kind of milk being produced. The necessary extra time to produce clean milk is less than many suppose. Whittaker [2] gives as the additional time necessary to raise ordinary conditions 16 points in score, only 15 minutes per cow per day. He summarizes conditions involving expense as follows:

Item.	Minutes per day per cow.
Cleanliness of cows	5
Cleanliness of stable and air	3
Cleanliness of milkhouse	2
Scalding utensils	1
Wiping udder	2
Removal of milk	2
Total	15

"To increase the score of a dairy from 42 to approximately 70 points, there may be in fifteen-cow dairies an added expense of 5 cents per cow per day for labor."

In large herds and where a high grade of milk is produced the following units of time for each operation will be found to be applicable:

Operation.	Time required per cow per day.
Cleaning stables of manure	3 minutes
Feed, grain and roughage	3.5 "
Groom	3 "
Wash cows	3 "
Bed cows	1.5 "
Milk cows twice a day	10 "
Total	24 minutes

These units are only applicable where the barn is convenient, and where the men do nothing but care for the milch cow and not the young stock which accompanies them. It is on a basis of each man doing a particular single operation. The man who feeds does nothing else, and the milkers only milk the cows.

[1] "Farm Management," p. 122.

[2] U.S. Dept. of Agr., Bur. of Animal Ind., Circ. No. 170, pp. 128–129.

A man can do the work in the barn where there are 20 to 25 cows, but when one man performs all the different operations he can not do them in the time stated. The above table does not provide for the time required to care for the milk and utensils. Where a system of soiling is followed, fewer cows still could be attended by one man. Under conditions where 20 or more cows are kept and where pasture is used for several months a figure of 180 hours per cow will be required. With ordinary care this figure may be reduced considerably. This accounts for the full time of a man 365 days at 10 hours per day for 20 cows. Time of course must be deducted for vacation and holidays, but this is compensated for by the decrease in labor when the cows are dry or when on pasture. It is therefore a fair and practical procedure to calculate the cost of labor on a basis of 20 cows per man, or to pre-calculate labor cost by dividing the cost of one dairyman per year by 20 to get the cost per cow. At a price of $45 per month, without board, the cost per cow is $27.

The cost of labor varies widely in different sections and also with the seasons, but the dairy furnishes employment fairly constantly for the men throughout the year. The study of labor cost is also desirable to show the returns for labor performed by members of the family when they are employed in the dairy.

The milking machine is being used to a considerable extent in some sections in an attempt to solve the labor problem. With 20 or more cows the machine will likely come into more general use. There is not, however, at the present time any accurate record covering long periods where actual time records show a decrease in cost due to the use of machines. It has been shown in experiments by the author and others that the machine in the hands of a careful man will milk a cow well and apparently has no injurious effect upon the cow. It has also been shown that with especial care milk with low bacteria content can be produced with the machine.

CHAPTER IV

THE COST OF BUILDINGS

In dairying a charge must be made for the use of the buildings. This is best figured from costs which include interest on investment, repairs, insurance, taxes, and depreciation. It is a rent charge. Several problems present themselves in a calculation of this cost. The first question to be answered is, which buildings should be charged to the cows? It has been customary to include buildings for cows and the storage barns for hay. Where hay is charged to the cows at market price it is not just to charge the cows with the storage barns also. It is necessary to have the hay barn even if cows are not kept. If the price of hay charged to the cows, however, is based on a price of purchase of the year's supply in haymaking season, the storage will of necessity be included in the cost of milk production. We shall not consider the storage-barn cost a proper charge to cows, for we have charged hay at market price, and it is necessary to have the barn to store the hay for market even where it is not fed to cows on the farm.

The cost of a barn for dairy cows varies widely, depending upon its durability, construction, convenience, and sanitary condition. It may pay to build more substantial barns, barns that will depreciate less, and be less subject to destruction by fire. The difficulty has been that methods of housing has changed frequently. The best shape or size of building has not been definitely determined. The tendency has been to construct expensive barns for the housing of dairy cattle where especially clean milk is produced. In some cases cows are kept in barns so expensive that the overhead charge for interest, taxes, and insurance has made profitable milk production an impossibility. The comfort and health of the animals, however, must be maintained. The present tendency is to

build less expensive barns or to provide only open sheds for dairy cows. In most sections this will greatly decrease the overhead, keep the cows in a more healthy condition, and decrease the cost of labor. Some large producers plan to have one central milking and cleaning barn and allow the cows to run in open sheds or in closed yards. This arrangement will do away with the expensive milk barns and greatly reduce the cost of labor, as it will not be necessary to keep so much space clean enough for the milking. Some expenditure for convenient barns often lowers the total cost of production by decreasing the cost of labor.

The open shed system, however, has not come into general use, and the calculations herein are based on the cost of permanent closed buildings. Stone, brick, cement, hollow-tile, and other permanent buildings for dairy cows have come into general use in recent years. The cost in some sections is only a little more than for frame buildings, and the depreciation and danger from fire is considerably reduced. The latter item is important, especially where a good strain of cows has been developed. Concrete floors with cement plastered walls are desirable from the standpoint of sanitation. They can be cleaned easily and thoroughly. Cork and creosoted wood blocks also are used. These make the bed for the animals more comfortable; they are not so cold, and the cows are less likely to be injured by slipping. It should also be noted that these floors require less bedding than where concrete is used, which in some sections is sufficient to warrant the additional expense, in view of the relatively high cost of bedding. The interest per cow on well-constructed buildings is comparatively high, but the depreciation is low. It has been the practice to build two-story barns, with the feed stored above. In a study of this problem made by the author it was found that no saving in cost results from the arrangement when the safety of the cattle is considered; also that with the proper arrangement of feeding facilities the labor required is not made greater by having separate buildings for the feed and for the cows.

A two-story barn must be built strong enough to hold the hay, and if a fire-proof floor is included the expense is consid-

erable. By storing the hay on the ground floor the cost of the storage barn is greatly reduced. The cows can then be housed in a separate one-story barn, which can be kept more sanitary and in which the cows are in less danger from fire.

The number of cows to be kept in a herd is a factor in unit cost of building. The cost per cow is less in a 50-cow barn than in a 20-cow barn of the same construction. The cost per cow for the barn varies in good dairies from $25 to $100 or more per head. A 50-cow barn of modern construction, such as a hollow-tile or concrete barn with concrete floors, walls, and ceiling, can be built for about $80 per head. This is for a good barn with proper ventilation system and modern sanitary arrangement, for a specialized dairy capable of meeting all requirements for the production of a high grade of milk.

Interest on investment may be figured at 5 per cent. The insurance will be from 0.2 to 0.4 per cent, depending on the relation to other buildings, etc. The taxes will vary considerably, depending upon the locality and method of assessment, and especially upon whether the enterprise is taxed separately or included in the whole farm tax. If assessed at one-half value, at a rate of 2 per cent, the item of taxes would be 80 cents per cow per year. The depreciation and annual repairs of a building of this kind would not amount to more than 4 per cent. A summary of the cost of building under these conditions would be as follows:

Interest, $80 at 5 per cent	$4.00
Insurance, $80 at 0.3 per cent	.24
Taxes, $40 at 2 per cent	.80
Depreciation, $80 at 4 per cent	3.20
Total unit cost of housing	$8.24

CHAPTER V

THE COST OF CATTLE

THE charge for cattle or for their use is the most disputed item of milk cost. A question that first arises is shall the cows be invoiced at cost of production or at a price at which they could be bought or sold as milch cows. Most cost accounts make use of the latter figure. The cows are valued at the beginning of each year at what is believed to be a fair sale or purchase price of the animals, even if they have been raised at less actual cost. This is not good business, for it inflates the capital really invested, and does not represent actual cost. In a previous chapter the feed charge is based on selling price of feeds raised on the farm; with cows, however, the cost of production is recommended as a basis for computing the cost. This may seem inconsistent, but the charges are not on the same basis, for the farm is independent of the dairy. The cost records are kept for the purpose of learning the income from the dairy itself. Profits may be secured from the farm and it is unfair to give to the cows the credit for the management and risk of that enterprise. The raising of cows, on the other hand, is a part of the work of the dairy, and, if the animals are sold the business is that of raising cows and not of producing milk.

In calculating the cost of cattle in milk production, therefore, the depreciation, interest, insurance, and taxes should be based on the cost of producing the cows if they are raised by the dairyman, or on purchase cost if bought. When the cost of production is less than purchase price for the same grade of cows, the advantage of raising the cows is apparent. Often, however, cows can be purchased for less than it would cost to raise them. To build up permanent dairies it is necessary to raise the cows, especially if a high-producing, healthy herd is

to be maintained. When high-priced cattle are purchased the overhead expense of cows is greatly increased.

In the raising of dairy cows to the age of two years the studies of Bennett and Cooper[1] furnish material for precalculating the cost. Careful records of cost for a period of 5 years were kept. The following amounts of feed were consumed, on the average, during the first two years:

	First year.	Second year.
Whole milk	342	
Skim milk	3,165	
Mixed hay	857	1,120
Corn silage	352	3,250
Grain mixture[2]	547	
Pastural, days	123	171
Corn stover		672

With these data the feed cost can be calculated. If we assume the same prices for feeds as were used in figuring the cost of feeds for cows, and with skim milk at 20 cents per hundred, whole milk at $2. per hundred, mixed hay at $15 per ton, corn silage $3 per ton, corn stover $6 per ton, and the grain mixture $1.15 per hundred, we find that with the above amounts consumed the feed cost to raise a heifer to two years of age is $47.51. Some of these prices will apply to present conditions; some are higher and some lower. They are used in order that the same basis of prices may be carried throughout this study.

The labor required to care for these animals during the first year was 40 hours, and during the second year 23 hours. At a price of 15 cents per hour, as is used above, the labor cost would be $9.45 per head for the two years.

The other expenses, including interest, buildings, equipment, bedding, loss by death, and miscellaneous expenses amount to $16.67 for the two years. This makes the total cost of raising the heifers, including feed, labor, and overhead, $73.63. A credit of $12 for manure for the two years makes the net cost for a two-year-old heifer $65.63. This corresponds very closely

[1] U. S. Dept. of Agr., Farmers' Bull. No. 49.

[2] Bran, 4 parts; oats, 5 parts; and oil meal, 1 part.

with other cost records. Truman [1] figured the total cost of a two-year-old heifer to be $70, but he added $4 as the initial value of the animal, while Lindsey [2] found the cost under conditions of higher cost of feeds and with an initial charge of $4 to be $74.24.

An initial charge for the calf should not be included, for there is no actual cost. The calves would be produced even if it were necessary to slaughter them at once. When a cost price for the calves is not allowed, the cost price of milk is more nearly accurate. With male calves not needed to maintain the herd, instead of a charge the calf represents a credit. The amount of credit to the herd for calves is discussed in a later chapter.

With the heifer coming into the herd at a cost of $65, it must next be determined how long she will likely be in the herd as a profitable producer of milk and how much she will be worth at the end of her period of profitableness as a milk producer. The amount of depreciation per year will depend upon the number of years the cow is profitable, and is the difference between the cost of the cow at entry into the herd and her sale price as beef. A high-cost cow depreciates more than a cheaper one, for both are worth about the same when sold for beef. Often the less expensive cow sells for more on account of her more beefy conformation. The length of usefulness of cows varies, but on the average the economic life of a dairy cow is much shorter than is generally believed, and is a large item of expense, especially where high-cost animals are kept. Various estimates have been made of the length of time a cow should remain in the herd. The average life of a cow according to Rasmussen [3] is about 6 years. According to actual records by Thompson [4] in herds of Delaware County, New York, changes in cows were made which indicated that the average productive life of a dairy cow was only 3.6 years, while in a survey of opinions of 174 farmers in the same county

[1] Mass. Agr. Exp. Sta., Amherst, Bull. No. 164, p. 70.
[2] Storrs, Conn. Exp. Sta., Bull. No. 63.
[3] New Hampshire Exp. Sta., Ext., Bull. No. 2, p. 12.
[4] New York Agr. Exp. Sta. (Cornell), Bull. No. 364, pp. 130–131.

the average is estimated as 5.8 years. The statement is made by Thompson that this is perhaps a more reliable figure. Studies in farm management by the U.S. Department of Agriculture [1] show that the dairy cows of Chester County, Pennsylvania, remained in the herd 4.34 years, while in Lenawee County, Michigan, they remained 4.52 years. Four, five, six, and seven years are given by different authors as the average life of a cow in the dairy herd. There is no doubt considerable difference in the productive life of a cow, due to varying standards of production. By one dairyman under certain conditions a cow may be considered a profitable animal, while with another under different conditions the same production would be unprofitable. In the studies made by the Department of Agriculture valuable data on the rate of depreciation of dairy cows have been assembled. The results are based upon the operations of 643 farms in Chester County, Pennsylvania. The data are offered to form a basis of obtaining the approximate average charge which must be made for depreciation in cows, and the authors say: "This method may be applied to an individual herd of cows as well as to the average of a large number of herds." The average annual loss in Chester County on dairy cows was 11.82 per cent of the average of the inventory value for the beginning of the year. Similar calculations for Lenawee County, Michigan, gave the annual depreciation as only 4.07 per cent. This difference is due to the difference in price at which cows are bought and sold in the two localities. In Michigan the average price paid for cows was $48.48 and the sale price of the discarded cow $42, while in Pennsylvania the cost was $63.84 and the sale price $37.36.

Although these data are valuable, the percentages can not be used except under the same conditions and prices. This is seen by the great difference in the percentages for Pennsylvania and Michigan. In an attempt to get a method that could be used under all conditions the formula $\frac{x-y}{n}$, where x represents the cost of the cows, y the sale price of discarded

[1] U. S. Dept. of Agr., Professional Papers, Bull. No. 341.

cows, and n the years of usefulness, was decided upon. A definite value for n is a problem that is attended by the difficulty of obtaining a figure that may be substantiated with actual figures. The length of use of a cow in herds where records of production and feed consumed are not kept can not be used, for it is not possible to tell without these data when the end of the cow's usefulness has come. This no doubt also largely accounts for the fact that during recent years the length of service of a cow apparently has shortened. Therefore records of cow-testing associations are resorted to. The actual ages when the cows are discarded are not recorded, but the ages of the cows are given. In records on file in the Dairy Division of the U.S. Department of Agriculture the ages of 13,856 cows in associations are given. These represent cows in different sections of the country, kept under different conditions of feeding and management, and in some cases represent the same group of animals for six or seven years. The ages of particular cows do not indicate definitely when these particular cows will die or become unprofitable, but the ages of great numbers indicate the probable length of life. For the determination to be more exact and similar to the method used by life insurance actuaries, a record of the cows of the different ages that die during any particular year is also kept. Owing to the large number of cows recorded and the long period of years covered, it is assumed that the average age at exit can be calculated from the number living at the different ages. In some sections a greater proportion of the cows may have been discarded the first year of the association, though it will be seen that in the associations that have been running for six and seven years the number of old animals does not increase. The following table gives the ages of cows in the 52 cow-testing associations reporting the ages of the 13,856 cows recorded by the Department of Agriculture:

AGES OF COWS IN COW-TESTING ASSOCIATIONS

Name of Association.	Year.	2	3	4	5	6
Canton, Maine	1908– 9	30	41	42	32	49
Minot, Maine	1910	23	70	82	94	92
Waterford and Norway, Maine	1909–10	18	57	48	62	50
Waterford and Norway, Maine	1911–12	21	38	43	47	35
Waterford and Norway, Maine	1912–13	31	52	39	35	31
Waterford and Norway, Maine	1913–14	31	58	34	35	25
Waterford and Norway, Maine	1914–15	23	61	41	28	28
Waterville, Maine	1910–11	31	29	17	13	25
Somerset County, Maine	1910–11	34	43	30	28	34
West Penobscot, Maine	1909–10	30	37	30	28	19
Winthrop, Maine	1908– 9	18	26	44	41	26
Newaygo County, Michigan	1906	12	39	26	31	27
Newaygo County, Michigan	1907	45	38	20	27	22
Newaygo County, Michigan	1908	11	29	23	24	30
Newaygo County, Michigan	1909	44	29	25	33	36
Newaygo County, Michigan	1911	65	61	46	15	15
Newaygo County, Michigan	1910	58	46	20	15	28
Newaygo County, Michigan	1912	71	63	46	28	11
Newaygo County, Michigan	1914	109	55	48	46	29
Stillwater, Pennsylvania	1914–15	84	88	85	68	59
Barron and Rice Lake, Wisconsin	1909–10	28	22	34	24	20
Barron and Rice Lake, Wisconsin	1910–11	14	37	22	30	30
Barron and Rice Lake, Wisconsin	1914–15	92	51	52	46	26
Black River Falls, Wisconsin	1914–15	33	72	33	37	36
Bloomer and Eagle Point, Wisconsin	1909–10	37	28	29	30	30
Bloomer and Eagle Point, Wisconsin	1913–14	10	29	22	14	13
Briggsville, Wisconsin	1910–11	14	27	15	21	22
Columbus, Wisconsin	1913–14	27	31	31	33	29
Clear Lake and Reeve, Wisconsin	1914–15	25	51	36	27	32
Eau Clair, Wisconsin	1914–15	21	36	26	22	24
Fennimore, Wisconsin	1914–15	38	52	57	17	36
Fox River, Wisconsin	1909–10	33	44	32	23	30
Gilmanton and Dover, Wisconsin	1914–15	23	69	62	58	38
Iola, Wisconsin	1913–14	44	45	29	48	44
Lake Mills, Wisconsin	1909–10	10	27	29	34	22
La Crosse, Wisconsin	1912–13	7	20	34	33	44
Ontario, Wisconsin	1914–15	44	35	43	19	23
Portage County, Wisconsin	1913–14	33	67	50	36	21
Preston, Wisconsin	1914–15	56	53	44	52	30
River Falls and Roberts, Wisconsin	1913–14	123	68	35	30	35
River Falls and Roberts, Wisconsin	1914–15	29	64	47	34	31

AGES OF COWS IN COW-TESTING ASSOCIATIONS — *Continued*

7	8	9	10	11	12	13	14	15	16	17	18	19	Total
35	39	21	14	4	6	5							318
57	60	46	28	8	4	5	4	0	1				574
43	33	22	14	1	5	1	2	1					357
27	21	17	17	9	13	2	0	1	2				293
21	22	21	9	10	7	5	1	0	1				279
24	23	12	17	4	3	3	2	1	0	1	1		274
27	20	19	16	15	4	0	1	2	2	1			288
20	20	5	11	5	2	0	0	1					179
29	22	11	8	5	6	3	1	2	0	0	0	1	257
20	15	9	3	5	5	3							204
27	5	11	5	1	5	2							211
14	25	15	14	2	4	0	1	1					211
26	25	11	11	11	5	2	0	2	0	1			246
19	18	22	15	7	3	11							202
42	31	19	16	4	3	3							285
25	16	27	12	7	10	2	0	2					303
20	35	13	14	11	3	2	2						267
14	23	9	21	9	7	5							307
17	14	6	2	4	5	0	1	0	1				337
65	59	30	15	8	2	0	2	0	0	1			566
13	16	9	3	5	3	3							180
14	11	5	7	2	2	0	1						175
21	23	10	13	1	1	0	0	0	0	1			337
17	22	7	6	1	2	1	2						269
16	15	3	1	4	1	0	0	0	1				194
7	7	2	5										109
20	28	21	12	6	4	4	1						195
27	12	6	4	3	2	0	2	1					208
13	12	4	6										206
14	15	10	7	4	4	3	1						187
31	26	14	3	6	2	1	2						285
18	17	17	14	5	9	0	4	1					247
31	27	19	10	9	6	0	2	0	2	1			357
31	23	15	11	2	4	1							297
14	7	11	5										159
35	42	15	8	6	2	1	1	1					249
19	22	12	6	2	3	0	1						229
14	18	13	7	2	6	1							268
24	20	12	8	5	3	2							309
33	24	10	10	2	2								372
32	24	11	7	1	2								282

AGES OF COWS IN COW-TESTING ASSOCIATIONS — *Continued*

Name of Association.	Year.	2	3	4	5	6
Sparta, Wisconsin	1909–10	40	31	27	31	24
Stanley, Wisconsin	1912–13	3	28	34	39	37
Tomah, Wisconsin	1909–10	21	36	35	31	31
Waukesha, Wisconsin	1909–10	7	19	26	22	16
Waupaca, Wisconsin	1913–14	58	47	36	54	21
Waupaca, Wisconsin	1914–15	78	102	55	48	45
Waupun, Wisconsin	1911–12	47	39	29	31	35
West Salem, Wisconsin	1909–10	40	44	56	40	32
West Salem, Wisconsin	1910–11	25	49	33	44	42
Whitewater, Wisconsin	1909–10	23	39	38	18	29
Wiltse, Wisconsin	1913–14	44	31	42	65	42
Total		1916	2,353	1,962	1,821	1,641

It will be noticed that there is an increase in the number of three-year-old over the two-year-old cows. This is accounted for by the fact that some are not bred to enter the herd until three years or almost three years old. In order, therefore, to get a figure for the probable number leaving the herd the first year, an average may be taken of the decrease between three years and six years as the decrease between two and three. This is found to be 237. In some sections a larger proportion of two-year-old cows are discarded during the following year than in others. Some discard heifers the first year if they do not produce a certain amount of milk, while others give the cows a longer trial. Assuming therefore that the decrease between two and three is 237, the calculation may be continued as follows:

Enter at two	1,916
Enter at three	674
Total enter	2,590
Assumed decrease between 2 and 3	237
Number 3 years of age	2,353

The next step is to get the average age at entry. Some dairymen make it a practice to have the heifers freshen at

AGES OF COWS IN COW-TESTING ASSOCIATIONS — *Continued*

7	8	9	10	11	12	13	14	15	16	17	18	19	Total
26	15	7	1	0	4	4	1						211
28	20	10	16	6	4	5	2						232
27	14	10	5	1	4	0	2						217
13	11	7	0	2	1								124
25	20	14	8	2	3	3							291
22	23	19	11	4	3	3	1	0	1				415
15	16	5	9	3	2	1	1						233
26	25	11	13	2	4	2	0	1					296
20	17	10	4	7									251
25	18	10	6	3	5								214
25	18	9	14	7	0	1	2						300
1,268	1,134	683	502	233	190	80	43	17	11	6	1	1	13,856

(Associations – 52.)

two years, while others for various reasons do not have them come into the herd until older.

$$1{,}916 \times 2 = 3{,}832$$
$$674 \times 3 = 2{,}022$$
$$5{,}854$$

5,854 divided by 2,590 = 2.26

The average age of entry into the herd is thus given as $2\frac{1}{4}$ years. But it is customary to consider an animal two until it is three years old; in some cases the nearest whole number is given as the age. The average, therefore, of the two-year-old heifers will be $2\frac{1}{2}$ and the three-year-old heifers $3\frac{1}{2}$ years old at entry, so one-half year must be added, giving an average age at entry into the herd of $2\frac{3}{4}$ years. In the table below the ages are given in whole numbers. The number of three-year-old heifers, for example, is 2,353, but these are really $3\frac{1}{2}$ on the average, and the average age at exit between $3\frac{1}{2}$ and $4\frac{1}{2}$ would occur at four years.

Age at exit.		Decrease.		
3	×	237	=	711
4	×	391	=	1,564
5	×	141	=	705
6	×	180	=	1,080
7	×	373	=	2,611
8	×	134	=	1,072
9	×	451	=	4,059
10	×	181	=	1,810
11	×	269	=	2,959
12	×	43	=	516
13	×	110	=	1,430
14	×	37	=	518
15	×	26	=	390
16	×	6	=	96
17	×	5	=	85
18	×	5	=	90
19	×	0	=	0
20	×	1	=	20
Total				19,716

The total, 19,716, divided by the number of exitants, which is 2,590, gives the average age at exit as $7\frac{3}{5}$ years. The average age at entry we found above to be $2\frac{3}{4}$ years, so that average life is $4\frac{17}{20}$ years. It is probable that if the present standard is maintained the years of usefulness will increase as the associations become older and as better care is given the cows. This, however, furnishes a figure which should be very near what may be expected, and if the cost of cows is computed on the basis of depreciation which replaces them every 5 years the herd will be maintained. There are many factors that shorten the economic life of a cow. Death is a small factor, and only accounts for 1.69 per cent in Pennsylvania dairies and 1.31 per cent in Michigan.[1] Udder troubles, tuberculosis, failure to breed, and accidents are some of the other causes for a shortened period of usefulness in milk production. Some valuable cows which continue to breed are kept after they are not profitable as milk producers, but this number is very small. In the formula below account is not taken of the cows

[1] U. S. Dept. of Agr., Professional Papers, Bull. No. 341, p. 65.

that die or those that can not be sold for beef; in general the relatively small number would have little effect on the average.

With a figure for the probable length of usefulness of a cow to determine the depreciation per year, all that is necessary is to subtract the final sale price of the cow for beef from the cost upon entry, and divide the result by 5, the average length of life in the herd. The formula would be $\frac{\text{first cost} - \text{final price}}{\text{length of life}}$. With a cow weighing 1,000 pounds, and cows selling for 4 cents per pound, and with a first cost of the cows of $65, the depreciation per year is $\frac{65-40}{5}=\$5$. The depreciation would be quite different if $200 cows were bought. In that case it would be $\frac{200-40}{5}=\$32$ per year. A few good calves may soon pay this extra cost, but when it is charged to the cost of milk it is an important factor. Depreciation is least when large, common stock is kept, for at the present high price of beef large cows can be sold for almost as much for beef as they could be raised for or bought as dairy cows. Some make it a practice to be constantly buying and selling cows, but this encroaches upon another business and should not be included in the cost of producing milk.

Interest, taxes, and insurance are other charges in the cost of cows. Interest may be figured at the same rate as above, 5 per cent, and taxes also at the same rate, although in many sections it is a common practice to base the taxes on the land, no greater taxes being charged where 50 cows are kept than where there is only one. Dairy cows are seldom insured against death by disease, except in the case of particularly valuable animals. Insurance against fire and storm is a small item. The total annual cost of cows is, therefore, as follows:

Depreciation, $\frac{65-40}{5}$	$5.00
Insurance, $65 at 0.3 per cent	.31
Taxes, $32.50 at 2 per cent	.65
Interest, $65 at 5 per cent	3.25
Total cost per cow per year	$9.21

CHAPTER VI

THE COST OF BEDDING

On the farm with a small dairy, especially where located some distance from the city or from markets, the problem of bedding is a small factor. In localities, however, where straw can be sold at a good price and where a large number of cows are kept bedding is a material item of cost. A great many substitutes are being used for bedding for dairy cows, sawdust and shavings being the most common. These are in quite general use on farms where high-quality milk is produced, because of the difficulty of getting straw that is free from dust. It has been thought by some that sawdust and shavings are injurious to the soil, though this has not been demonstrated. It is, however, certain that the manure is not so valuable as when straw is used. Waste hay and stover are also used to bed cows, but usually these materials contain too much dust.

When the cows are kept tied in rows and on a platform, the shavings and sawdust can be used with less work and will keep the cows cleaner. Baled shavings are preferred to all other kinds of bedding, for they can be handled with less labor, will absorb the liquid manure well, will stay where placed, making it possible to keep the cows cleaner, and are relatively freer from dust than straw or stover. Where the floor is tight and smooth both sawdust and shavings can easily be removed.

The amounts of the various beddings needed will depend upon the management, the length of time the cows are kept in the stable, and the nature and condition of the floor.

The absorptive properties of different bedding materials are given by Doane[1] as follows:

[1] "Tests of Material for Bedding Cows," Md. Agr. Exp. Sta., Bull. No. 104, p. 9.

Material.	Water absorbing power of bedding.	Pounds of bedding required to absorb for 24 hours.
Cut stover	2.5	4.0
Cut wheat straw	2.0	5.0
Uncut wheat straw	2.0	5.0
Sawdust	0.8	12.5
Shavings	2.2	4.4

Before making a calculation of bedding cost it is necessary to know the system practiced — whether the cows are kept in at night, or for how long each day, and the length of time on pasture. We may assume that they are kept in the barn 24 hours per day for 8 months. The other four months of the year they would be in the barn a few hours perhaps, but would likely not use bedding, except a little to absorb the liquid manure if there were no other means of collecting it. The amount of bedding needed per cow per year would therefore be 5×240, or 1,200 pounds of wheat straw, 12.5×240, or 3,000 pounds of sawdust, and 4.4×240, or 1,050 pounds of shavings. If we assume straw to cost $5 per ton, sawdust $1.50, and shavings $6, we get costs for bedding with straw, sawdust, and shavings of $3, $2.25, and $3.15, respectively. The prevailing price can be substituted in particular cases. Rasmussen[1] says that bedding cost at the New Hampshire Station one-half cent per bushel for sawdust and one and one-half cents for handling, making a total of two cents, and that on the average 200 bushels are required per cow per year, making a total cost of $4. Minkler,[2] of the New Jersey Station, bedded cows with one bale of shavings per 20 cows, at a cost of $5.30 per cow per year.

[1] N. Hamp. Exp. Sta., Ext. Bull. No. 2, p. 14.

[2] New Jersey Exp. Sta., Thirty-first Annual Report.

CHAPTER VII

THE COST OF SIRE

THERE are two factors that determine the cost of the sire per cow, namely, the expense of keeping the sire and the number of cows served. The first cost of a bull varies greatly, and ranges from the cost of raising to hundreds and even thousands of dollars. It requires for a particular herd no more expenditure to raise a good bull than a poor one, but the initial cost is more, and if the bull has especial promise or has been tried and especially good animals secured, his sale price and also his intrinsic value may be very high. The effect of a sire that will get daughters with greater production ability than their dams is worth much to the herd that is being developed. From the standpoint of cost of production of milk of a particular generation, it is not correct to figure the cost of sire on the basis of an expensive animal, for a cow will be no better as a producer and no more economical in her production because of the use of a good sire in getting her calves. The calves are of greater value, which will increase the cost price of cows in the next generation. A bull that will be likely to give calves equal to or better than the 8,500-pound producers taken as a basis of calculation in a preceding chapter would cost perhaps $50 when a few days old. It would cost somewhat more to raise a bull to two years of age than a heifer, but the bull could be used some during its second year. It is reasonable, therefore, to assume a cost of $100 for the bull at 1 to 1½ years of age. The expense of keeping a bull is somewhat different from that of keeping a cow. More room is required and more bedding is needed, while the feed will be somewhat less than that required by a high-producing cow. The taxes, interest, and insurance should

be considered on the same basis as in the case of cows. The depreciation is greater, because the initial cost is higher, and the period of usefulness in a herd is no longer, on the average, though sometimes the bull may be sold at a price greater than he would bring for beef, for use in another herd. A bull usually is heavier and, unless old, will sell for more as beef than a cow. On the average, 4 years is as long as a bull can be used in one herd to advantage, unless a large herd is kept and several bulls are used. In this case the bull could be used with cows from other bulls.

On the basis of $100 for the sire, the following cost per year must be charged as a part of the expense of producing milk:

Feed	$50.00
Labor, 160 hours at $0.15	24.00
Depreciation, $100 to $60 in 4 years	10.00
Interest on $100 at 5 per cent	5.00
Insurance, $100 at 0.3 per cent	.30
Taxes, $50 at 2 per cent	1.00
Total cost per year	$90.00
Credit for manure	20.00
Net cost per year	$70.30

The number of cows served by the bull is the greatest factor in the cost per cow. A bull will serve as many as 100 cows during the year, or even more, but in practice the service is not regular, although an attempt commonly is made to have fresh cows at different seasons. It should also be remembered that there are not so many or seldom as many as 100 cows in the herd. The greater part of the milk of this country, as is suggested above, is produced by small herds, and it is in these that the bull service is so high, especially where expensive bulls are kept. Following the table above, with a herd of 10 cows the service per cow would be $7.03 per year, while in a herd of 20 cows this cost is only one-half as much. The manure produced must be considered as a credit. It is not quite so much in value as from a cow fed for large production. For a bull more bedding is required; the labor is about the same as that required in caring for a cow. The bull usually is kept in a separate pen, so that more time is required to

groom him and clean his stall, but the time spent in milking the cows is saved.

The cost of the sire is greatly reduced by coöperation of owners of small herds. Where several farmers in a neighborhood organize and form what is known as a Bull Association, this burden of expense is greatly lessened. There may be some inconvenience in such a plan, and there is also danger of disease being carried from farm to farm, but these and other apparent objections are being met, and the plan is destined to prove valuable in building up our dairy herds and in decreasing the cost of milk production.

CHAPTER VIII

MISCELLANEOUS EXPENSES

On a well-equipped dairy the miscellaneous expenses are considerable. One or more of the items mentioned below may not be necessary as costs for a particular dairy. For example some dairies have good springs or an abundance of cold water, so that ice is not needed. Under conditions, however, where the milk must be prepared for shipment in a short time, ice may be needed, even where there is a good supply of cold water. In some sections ice can be stored at a small cost, while in other sections it is necessary to buy ice at relatively high prices. According to Rasmussen[1] about one ton of ice is needed per cow per year to cool the milk of an 8,500-pound producer, this being the amount produced by the cows in the Wisconsin herds to which these formulae have been applied. This makes a rather large item under conditions of high cost of ice, but the amount cooled is more than twice the production of the average cow. The actual cost of ice in the 174 herds of Delaware County, New York,[2] was only about $.50 per year per cow. More than one-half the dairies of this country use no ice at all. Supplying wood and coal for heating water and for steam where sterilizers are used adds another annual expense item of 25 to 75 cents per cow.

Tools and special equipment such as scales, curry combs, brushes, cards, clippers, forks, shovels, and carts and carriers constitute another expense, which will amount to 50 cents to $1 per head on a well-equipped dairy. The utensils needed, including pails and strainers, sterilizers, cans, and other tinware, will cost about $1 per year per cow. Supplies such as medicine, salt, soap, disinfectant, and fly exterminator cost

[1] New Hampshire Exp. Sta., Ext. Bull. No. 2, p. 15.

[2] New York Agr. Exp. Sta. (Cornell), Bull. No. 364, p. 133.

from a few cents to $1 or more per cow. In surveys in New Hampshire Rasmussen [1] found that medicine alone amounted to about 45 cents per cow.

Another incidental expense is that for veterinary services and for the supervisor of cow-testing associations where such are used. On the average dairy the dairyman should be able to handle ordinary diseases and should seldom be obliged to call a veterinarian. An occasional visit from a veterinarian is, however, necessary. The supervisor of a testing association does a necessary work in herd management and can usually do it cheaper and better than the dairyman. The cost of this service depends upon the size of the herd. An average charge of $1.50 per cow per year will cover it in most localities, while the veterinary fees ought not to exceed 50 cents to $1 per year per head.

Where the milk must be delivered to a station or creamery, or even to a city, which involves the expense of hauling and railroad transportation, a very material expense is incurred. In the investigation of conditions in New England by the Boston Chamber of Commerce [2] the average cost of collecting and hauling to the station was about one-half cent per quart, while the cost of railroad transportation on different lines averaged about the same. With the 8,500-pound producers the cost of hauling and transportation at these rates would be over $18 per year per cow. Long hauls with small quantities of milk in some cases are made at a cost that makes the milk business unprofitable. Coöperation in hauling greatly reduces the cost to small producers. In studies by Hopper and Robertson [3] the average cost for delivery of 100 pounds of milk was 11.7 cents, with an average hauling cost of $145.16 per farm per year.

This, although another item of legitimate charge to the cost of production of milk, in some cases is not a real extra cost. Often the country boy delivers a can or two of milk on his way to school, so that although an actual expense would

[1] New York Agr. Exp. Sta. (Cornell), Bull. No. 364, p. 133.
[2] "Investigations of Milk Situations in New England."
[3] New York Agr. Exp. Sta. (Cornell), Bull. No. 357, p. 151.

otherwise be required to deliver the milk, it is done in this way at no real cost. The total of $18 for hauling seems high, but it is a reasonable charge. At 11.7 cents per hundred, hauling 8,500 pounds of milk costs $9.80, leaving about $8 for railroad transportation. When this is paid at the farm this item should be considered in determining the price at which the milk should be sold.

All these costs may be brought together as follows:

Ice, 1 ton at $1	$1.00
Wood and coal	.75
Utensils	1.00
Supplies	1.00
Veterinary service and tester	2.50
Hauling and transportation	18.00
Total miscellaneous expense	$24.25

These items cover conditions above the average, but no better than are necessary for the production of high-grade milk such as is now being demanded. Most farms use no ice, no wood or coal for steam, and no sterilizers. The items of tools, utensils, and supplies may be reduced in some cases, and the cow tester is not an expense on most farms, although with this service the cost would in most cases be returned many times by the increased efficiency of the herd. Not only do the records of the supervisor of the cow-testing association show the profitable and unprofitable cows, but the tester is a great help in the selection of calves to be used in future herds, thus making intelligent breeding and herd improvement possible. The large item of $18 for hauling and transportation should be deducted if the milk is sold at the farm and is received there by the dealer.

CHAPTER IX

CREDIT FOR CALVES AND MANURE

It is difficult to determine an average credit for calves, as they range in value from almost nothing to $50 or more when born. The calves that can be sold for the high prices, of course, add an expense to production, namely, the cost of phenomenal breeding stock with very highly bred, high producers. The added expense of caring for such animals, the expense of advertising and selling, and the great increase in depreciation and risk must all be included when the larger credit for calves is allowed. It is assumed for present purposes that the primary business is the production of milk. From an ordinary milk herd the calves usually are sold as veal. The number of calves to be credited to the herd each year will not exceed four-fifths of the number of milch cows, and when failures to breed, accidents, and deaths of calves are considered, the number to be disposed of will not average more than three-fourths of the number of cows in the herd. Some calves must be kept to replace the cows, which, it has been estimated, must be replaced on the average every fifth year. This gives a credit per cow of three-fourths of the price at which calves are worth in initial cost. The one-fourth is not credited to the cows, for no charge is made as the initial cost of the calves raised. When all the calves are credited to the cows, the initial cost must be included in the calculation of cost of cows.

The price at which a dairy calf can be sold when the milk of a cow becomes normal, usually in three or four days, is in most instances very small. For veal, a large calf when fed and marketed at best advantage may bring a price that will warrant the expenditure of $5 to $6 and in exceptional cases a little more for raising, but many calves do not pay for the

milk consumed and the labor invested in them. With a fair-sized cow, such as is assumed in this discussion, an average of $4 per calf is a fair sale price, and if fed 6 weeks the value of the calf for veal would likely not warrant an initial charge of more than this. Three-fourths of this gives a credit of $3 per year for each cow in the herd. Under conditions prevailing in many sections the demand for heifer calves from cows as good as the standard assumed herein would command as much as $10, but of the three-fourths that could be sold about one-half would be male calves, so that the credit possible under these conditions would add but little to the credit per cow allowed above.

The actual value of the manure produced by dairy cows depends upon the kind of concentrates and roughage fed, the nature and condition of the soil, and the productive value of the land and the value of the crops grown. In cost estimates various methods have been used to calculate the credit to be allowed each cow for manure, and values of $8 to $36 are given. Perhaps the most commonly used figure is $15. Rasmussen[1] arrives at this figure by assuming that 13 tons are produced and the fertilizing value of fresh manure is $1.90 per ton, making a total value of $25. From this he deducts two-fifths for hauling and loss due to leaking and fermenting. The cows, however, should not be charged for careless handling of manure, but should be given credit for it to the limit of practical methods of conserving the material. Rasmussen, like most other authors, bases the value of the manure upon the cost of mineral fertilizers required to furnish the fertilizing elements in similar amounts. If the land of a particular dairy needs these elements, and if they must be purchased in the form of mineral fertilizers where not supplied by the dairy, the method of basing the value of the manure on the cost of the commercial fertilizers needed to supply the same quantity of the fertilizing elements is correct. The humus furnished by manure is of considerable value on some fields, while others seem to produce as well with commercial fertilizers when a proper rotation is followed and green crops are

[1] New Hampshire Exp. Sta., Ext. Bull. No. 2, p. 16.

turned under. The value of manure is thought by some to be overestimated when based on the fertilizing elements it contains. When the full amount is credited at cost price of the elements and the cows are fed a heavy grain ration, a large figure for manure is obtained. In an experiment by Roberts [1] in which 18 cows were kept in the stable and given a fairly liberal ration the results indicated in the table below were obtained. The liquid manure is included. The value is based upon a price of 7 cents per pound for phosphoric acid, 15 cents for nitrogen, and 4.5 cents for potash.

	18 cows for one day.	Average for 1 cow per day.
Weight of cows, pounds	20,380	1,132
Food consumed, pounds	1,347	75
Water drank, pounds	876	49
Total excretions, pounds	1,452.5	81
Nitrogen, pounds	7.35	.41
Phosphoric acid, pounds	5.01	.28
Potash, pounds	7.40	.41
Value of nitrogen	$ 1.10	$ .06
Value of phosphoric acid	.35	.02
Value of potash	.33	.02
Total value	$ 1.78	$ .10
Value per ton	$ 2.27	
Value per animal per day	.093	
Value per 1,000 pounds live weight per day	.082	
Value per 1,000 pounds live weight per year	$29.82	

From this must be subtracted the cost of hauling the manure to the field. At 50 cents per ton [2] and on a basis of 12 tons, the deduction is $6, leaving the value for manure as about $23. Some loss takes place even under the best known system of handling manure, but the value of the humus and the straw used for bedding is not charged. The amount [3] and kind of grain fed to the cows is a factor in manure value, feeds high in protein making more valuable manure. A sum-

[1] New York Agr. Exp. Sta. (Cornell), Bull. No. 27.

[2] "Cost of applying manure," Minn. Agr. Exp. Sta., Bull. No. 145, p. 48.

[3] "The Feeding of Crops and Stock," A. D. Hall, p. 234.

mary of studies in the manurial value of excreta of milch cows by Sweeter [1] shows the relation of feeding to manure value:

1. "The feces from milch cows contains $\frac{1}{3}$ of the nitrogen, $\frac{3}{4}$ of the phosphoric acid, and $\frac{1}{6}$ of the potash of the food.

2. "The urine contains $\frac{1}{2}$ of the nitrogen, almost no phosphoric acid, and $\frac{3}{4}$ of the potash of the food.

3. "The milk contains less than $\frac{1}{6}$ of the nitrogen, $\frac{1}{4}$ of the phosphoric acid, and $\frac{1}{10}$ of the potash, or less than $\frac{1}{6}$ of the manurial value of the food.

4. "When the urine is allowed to waste, more than $\frac{1}{2}$ of the food, or 63 per cent of the manurial value of the solid and liquid manure is lost."

Another method is to compute the value of manure on a basis of increase in the value of crops. In farm management studies by the U.S. Department of Agriculture [2] this plan is being followed. The average value of the crops, corn, potatoes, wheat, oats, and hay on well-stocked farms in Pennsylvania is given as $15.80 per animal unit more than on similar farms with few animals. The animal unit, however, includes animals other than dairy cows, which supply more fertility than any other domestic animals. In similar studies in Michigan the corresponding figure has been estimated as $8.22. The difference is accounted for by the greater need for mineral matter in the Pennsylvania soil and by the better care given manure in Pennsylvania because of its higher value. This difference shows that the value depends upon conditions and needs of the soil of the dairy farm, and must to a large extent be calculated with respect to each particular case. The increase in crop value, however, usually is underestimated when long periods of time are considered. Under conditions where cows are well supplied with concentrated feeds and where the manure is properly cared for, a cow of 1,000 pounds weight will furnish $20 worth of added fertility per year. The practice in England,[3] which is covered by a law affecting landlord

[1] Penna. Agr. Exp. Sta., Bull. No. 54, p. 7.

[2] U. S. Dept. of Agr., Professional Papers, Bull. No. 341, p. 96.

[3] Jour. Royal Agr. Soc., 193, Reported in Jan., 1915. Jour. Board of Agr., pp. 931–934. Also "Feeds and Feeding," Henry and Morrison, p. 277.

and tenant, gives a tenant credit for all manure resulting from purchased feeds given to stock, on a basis of $\frac{3}{4}$ of the total value of the phosphoric acid and potash in the feed, allowed for all unused manure. A credit of 70 per cent of the total value of nitrogen is allowed when the stock is fed on pasture, and of only 50 per cent when it is fed in the barnyard. When one crop has been grown after application of the manure, a credit of one-half the above amounts is allowed.

There are tables in the English publications referred to above giving the amounts of nitrogen, phosphoric acid, and potash voided from the various grains fed to dairy cows. Given the quantities of feed consumed and the prices for the elements needed on a particular farm, the real value of manure under particular conditions of soil and feeding can be definitely ascertained.

CHAPTER X

APPLICATION AND USE OF FORMULA

The costs and credits incident to milk production may now be summarized. Under the conditions stated for each item, which include a particular size and kind of cow, producing 8,500 pounds of 4 per cent milk with feeds at stated prices, with the system of management given, and with a good barn well equipped for the production of high-grade milk, cost records will show the following as actual costs in the production of milk:

	TOTAL COST.	
1. Feed	$75.29	
2. Labor	27.00	
3. Buildings	8.24	
4. Cattle	9.21	
5. Bedding	3.25	
6. Sire	3.51	
7. Miscellaneous expenses	24.25	$150.75
	CREDITS.	
1. Calves	$ 3.00	
2. Manure	20.00	23.00
Net cost per cow per year		$127.75

The average standard of production of these cows is assumed as 8,500 pounds per year, which was also the average production of the 985 Guernsey cows used in the Wisconsin test, upon which the data in this study are based. Figuring 2.15 pounds to the quart, the production is 3,441 quarts. Thus the cost of production per quart is about $3\frac{3}{4}$ cents. The cost of 100 pounds, therefore, is $1.50. The Sheffield farms, Slawson-Decker Company, New York,[1] perhaps the largest independent milk company in the United States, recently announced its price schedule for milk as follows:

[1] *New York Produce Review, American Creamery*, p. 975.

Months.	1916.	1915.
April	$1.70	$1.75
May	1.40	1.40
June	1.40	1.40
July	1.60	1.50
August	1.75	1.65
September	1.80	1.75

This is for milk testing 4.5 per cent, which is one-half per cent less than the standard used herein in calculating feed cost. They, however, allow a premium of 4 cents per hundred pounds for each one-tenth per cent butter-fat above 4.5 per cent. Five per cent milk would be paid for at a rate of 20 cents more per hundred. Still further premiums are offered for milk of Grade A, which are provided for in these cost calculations in preceding pages. The winter prices are prevailingly higher, but the production then is less. The average price of milk of Grade A, testing 5 per cent, in New York is $2 per hundred pounds. In some sections this price is less.

It should be further pointed out that the prices for feeds are somewhat lower than prevail at the present time. At prevailing prices for feeds the costs would be increased to $90.49, and the total costs to $143.36, and the profit per cow may be determined as follows:

Sale price of 8,500 pounds of milk	$170.00
Cost of production of 8,500 pounds of milk	142.95
Profit per cow	$27.05

In a 20-cow dairy the profit for the year on this basis is $532.80, in addition to an income of 5 per cent for all capital used in the enterprise. The assumed total capital invested is about $9,000. When the disease risk to the animals is considered, the profit under these conditions is not great, though satisfactory.

For the standard herein, however, unusually high-producing cows were selected. The average production of the cows of the United States is only about 3,000 pounds. Animals of this sort present a very different outlook for the business. We may assume that cows of this standard are used to supply milk to the same market, that is, Grade A. By referring to a

preceding chapter we find the food for maintenance would be the same, and for 3,000 pounds of milk is as follows:

	Protein.	Energy.
Maintenance, 5 × 280 =	140	6 × 280 = 1,680
3,000 pounds milk, 962 × 3,000 =	186	.36 × 3,000 = 1,080
Total amount needed	326	2,760
Supplied by hay	90.89	583.63
Supplied by silage	61.60	1,159.20
Total amount supplied	152.49	1,742.83
To be supplied by grain	173.51	1,017.17

A ration of a ratio of 1:6 would supply this need. Using the same feeds in slightly different proportions to give the needed balance of 1 to 6, the following amounts of feed would be required by cows of this production:

Feed required, with costs.

1,680 pounds of hay, at $.80 per 100	$13.44
7,000 pounds of silage, at $.15 per 100	10.50
450 pounds of corn, at $1.00 per 100	4.50
300 pounds of dist. grains, at $1.50 per 100	4.50
300 pounds of bran, at $1.50 per 100	3.15
300 pounds of oats, at $1.10 per 100	3.30
Pasture for season, at $5.00	5.00
Total cost of feed for the year	$44.39

The cost for feed, therefore, would be $30.90 less per year. The cost of labor, buildings, and bedding, and miscellaneous expenses would be the same, while the cost of sires and cows would be decreased only by the initial cost of the latter, which would only decrease the cost per unit cow by a few cents. The cow would cost as much to raise, but if purchased could be obtained for a lower price. The total annual cost, then, to keep cows of this kind would be $97.26. The milk at the same price of $2 per hundred pounds would bring $60, which would make a loss of $37.26 per cow per year. This is what may be expected at present prices of feed and labor from cows that produce no more than the average cow of the United States, when a dairyman attempts to produce milk of good grade, in good barns, using full grain rations, and practicing year-round feeding.

A further analysis may be made: Let us assume that the cows are kept in a building worth only $1,000, that the cattle are kept on pasture and fed chiefly straw and stover during the winter, that the bedding could not be marketed, that much of the hay could not be sold at $16 per ton on account of being damaged by rain, that the equipment is relatively incomplete and inexpensive; also assume that the cows are fed less grain, producing most of the 3,000 pounds while on pasture, and only given stover, straw, and perhaps a little grain in the winter. The item of labor under this system would be less. Under these conditions the annual cost of keeping cows could be decreased to $60, or the sale price of the milk. Some dairymen would continue under these conditions for the pay of $27 per cow per year for labor.

With the data in the preceding chapters comparisons can be made of each item of cost, so that they may be taken as a guide to cost under any condition of management or prices.

An application of the formula warrants the following conclusions:

1. Under present prices of feed and labor a herd of high-producing cows will when properly managed return 5 per cent interest on the capital invested in a good plant, and an additional 5 per cent for services of the manager not included in regular labor charge.

2. The average cow of the United States does not produce enough milk to pay the cost of production when managed under the same conditions and equipped to produce high-grade milk.

3. Where the herd uses feeds that can not be marketed, where a cheaper system of management is used, and where the cows are housed in cheaper buildings and given less care, they may pay the cost of production of milk.

4. Under some conditions, summer dairying would be more profitable than the all-year practice.

5. It does not pay to use intensive methods or winter grain feeding with low producing cows.

6. The value of pasture for dairy cows has been underestimated.

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