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THE COST OF MILK PRODUCTION .

by

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THE COST OF MILK PRODUCTION.

INTRODUCTION

To teach the farmer how to analyze his business and thereby determine efficient farm methods as applied to his particular conditions is one of the biggest problems confronting the agricultural workers of the present day. Agriculture has for a long time been, to a large extent, a hit-and-miss industry because the farmer is unable to put his finger on the exact source of his gain or loss. He seldom knows which part of his business or what methods are making his money and which are sources of leaks. This is as true in the dairy industry as in any other line of farming. The object, therefore, in discussing a subject such as "the cost of milk production" should be to analyze the factors of cost and to thereby help the dairyman to a better understanding of these factors. Such an analysis, when applied by the individual dairyman to his own conditions, will enable him to determine which factors are the most responsible for his gain or loss and which should be remedied.

That the production and distribution of milk in this country is not on a sound economical basis is indicated by the numerous milk strikes during the last year. It has been apparent for some time that such a condition exists and that there is something wrong in the way this important industry is now being conducted. The producer 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 is made from time to time in the price of milk. This condition of milk prices has lead to considerable unrest in the dairy industry. State and federal experts have studied the problem, and extension and country agricultural workers, city chambers of commerce, special committes appointed by citizens, boards of health, and other municipal organizations and officers are devoting considerable time to the study of milk costs. It is the purpose of the author in this study to deal with the problem only from the standpoint of the cost of production on the farm and to not include the subject of distribution, which constitutes a problem of perhaps equal importance.

Milk is one of the most important of our agri-

cultural products. It has always been a staple article of consumption with all classes, and is among the best and cheapest foods on the market. There is no substitute for it and it will always be in demand. Such an adjustment of conditions as will enable the dairyman to produce milk at a reasonable profit must eventually be made.

Before we can determine what is a just and fair price for milk it is necessary to have some definite knowledge as to what it costs to produce good, clean, wholesome milk. Surveys and cost records of the dairy often show that although the farmer may be making a fair wage and interest on his investment, the profits are not derived from the cows. Without cost accounts for the dairy itself it is impossible to determine to which enterprise the profits or losses are due.

DISCUSSION OF PRESENT DAY CONDITIONS.

Before attempting to analyze the factors in milk production costs it may be well to present a brief discussion of the present day conditions in the milk producing end of the dairy industry.

Almost every dairy in the United States is a part of a general farm proposition. However, the fact that a farmer milks a few cows does not necessarily mean that he should be classed as a dairy farmer. Dairy-
ing as a major proposition in the farm enterprises is a comparatively new business to most of our farmers in this country and it seems that a proper adjustment of conditions has not as yet been brought about. There is in general a lack of any standard methods of production and a lack of accurate knowledge of cost of production.

The selling of milk and cream to the commercial creamery and cheese factory are not old, established industries. Fifty years ago saw the first commercial creamery. General shipping, to any great extent, of milk and cream by cars began less than forty years ago. Formerly farmers sold from their farms, for their cash income, grain, hay, cattle, sheep, wool, hogs, poultry,

eggs, and home-made cheese and butter. Today comparatively small amounts of cheese and butter are made on the farm and most of the milk or cream is sold to commercial milk companies, creameries, or cheese factories.

Because of the varying amounts that the milk or cream check contributes to the total amount of money received from all the farm products, we divide the milk producers into two main classes. (A) Those whose main business is milk production. This includes producers whose milk or cream sales amount to 60 per cent or more of their total farm income. (B) Those with whom milk production is a side issue. In this class are included producers whose milk or cream sales do not represent the major part of their farm income. The (A) producer is generally more concerned about his dairy business than the (B) producer and pays more attention to the problems of breeding, feeding, amount and cost of milk production, etc. However, the (B) producers are a big factor in the dairy industry and produce in the aggregate a large amount of milk and cream for the market.

The problems presented by these two classes of producers are quite different. The farmer with whom dairying is a side issue produces milk under different conditions than the specialized dairy farmer. The feed

cost is usually much less. The cows are kept mainly for the purpose of utilizing rough feeds such as corn stover, poor hay, rough pasture land, etc. which otherwise would be of little or no value. But little if any grain is purchased for the cows. The labor costs are at a minimum and often the cows do not required any expense for labor. During the winter this class of farmers are not very busy and the time spent in caring for the cows is of little account because the farmer would otherwise be idle. During the summer the women and children do the milking and the cows are on pasture where they require but a small amount of care. The cost of buildings and dairy equipment is also very low. The cows are housed in a barn or shed which was built primarily as a horse stable or for grain and hay storage. The equipment consists of a home-made milking stool, a few milk pails which are often used for other purposes, a few milk cans in which the milk or cream is delivered. The cost of sire and incidental expenses are correspondingly very low.

Cows kept under these conditions have a low production. However, they furnish cheap food for the farmers family where milk is used in relatively large amounts and the milk or cream check, although perhaps

not very large, is mostly net gain to the farmer because the cows utilize feed and labor which would otherwise be of little or no value. This is especially true of the farmer who is ^aconsiderable distance from the shipping station in which case the cost of marketing these rough feeds is often more than their market price.

Milk produced under these conditions is often of a low grade but it constitutes a large part of the milk supply of our country. Because of the low cost of producing such milk, this class of producers can continue to keep a few cows and sell milk at a much lower price than the specialized dairy farmer.

Another factor which may be of considerable importance in the future is the advent of foreigners in the dairy business. Many foreigners are taking up farms and producing milk, working the entire family on the farm. Few of these figure labor costs, but their milk comes in direct contact with that of the producer who figures each item of cost.

In the case of producer with whom milk production is the main business, the price received for the milk is of vital importance. His cows are the medium through which he markets most of his farm crops and these feeds must be charged to the cows at the farm

market price. The utilization of rough feeds and by-products of the farm is a small factor in his feed costs. His expense for labor and his investment in buildings and other equipment are relatively higher per cow. Hence, unless the market price of milk is in accordance with the price of feed and other costs the dairy is not a paying proposition.

A knowledge of the various items which enter into the cost of milk production would enable the dairy farmer to ascertain the minimum price requisite to yield him a profit. Investigations show that very few producers have any definite knowledge as to what their milk is costing them. Estimates by different dairymen under similar conditions vary so much that their estimates are of little or no value. Except for a few farmers who are members of cow testing associations, they do not even have records of the milk produced by their cows. Much less do they have any record of the food eaten, labor required, and other items of cost. However, the producers are practically unanimous in the opinion that they are not receiving enough for their milk. They see only one solution of the problem and that is higher prices for milk. The essential causes for the difficulty are "the lack of a standardized

product" and "lack of accurate knowledge of cost among the farmers".

The value and a large part of the cost of a quart of milk or cream depend on its cleanliness and percentage of butter fat and solids not fat which it contains. These percentages vary greatly with different samples. Butter fat can be readily measured when the farmer offers his product to the dealer, and the farmer or dealer can, by proper mixing or standardization, control it in the product which they offer to the consuming public. These percentages together with the cleanliness of the product, should govern both the price paid by the consumer and that received by the producer.

The methods now prevailing in the trade often fail to give these factors the emphasis which their fundamental importance deserves. The minimum legal requirements in the various states are far from uniform and no well recognized grades of milk or cream have yet been established in the trade. In many cases the farmer receives practically the same price irrespective of the quality of his product; the consumer pays about the same whether the food value of what he buys be high or low. While many farmers and dealers do attempt to

base their transactions on the cleanliness and percentage of solids in the product, the lack of any well defined and recognized standard and the indifference of the consumer tend to discourage such dealings. "Milk is Milk" and is sold without definite description, and the general result is a lack of incentive to both the farmers and the dealers to improve their product.

Partly as a result of this absence of a standardized product and partly because of the difficulty of keeping records, farmers are now selling their product without accurate knowledge of either its value or its cost to them. This lack of knowledge on the part of the farmer hinders improvement being made in the methods of production and tends to destroy the cordial relation which should exist between the country producer and the city dealer. When the producer fails to prosper he attributes it to the low prices paid by the dealers. The dealers on the other hand are apt to regard as extortion every attempt made by the producers to raise the price. To remedy this condition the producers must acquire accurate knowledge of the cost of production sufficient for them to eliminate waste and to ascertain definitely the minimum price requisite to yield them a profit.

Cost determination is essential to efficiency. It not only furnishes a guide to a profitable selling price, but also enables the producer to control the different factors of cost. A complete and properly arranged statement of costs enables the dairyman to study and compare methods and finally to determine by which methods he can produce milk most cheaply.

REVIEW OF LITERATURE.

A review of the various bulletins and reports on the cost of milk production seems to indicate that a large majority of the dairymen in this country are selling milk for less than it costs to produce it. One of the strongest statements is made by Professor Lindsey¹, who, in discussing the results of an experiment covering 15 years, says:

"It is evident from our own figures and from those derived from other sources that under present conditions it is not a satisfactory business to attempt to produce reasonably clean milk under 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 increased if the producer invests capital in a modern barn and well equipped dairy house, if the 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 author that in the past a great deal of the milk has been 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 expenses, and the like, all of which are absolutely essential. In other words the keeping of accurate accounts and the application of ordinary business methods have too often been 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 establishment of a relatively low wholesale and retail price.

"Now that the 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 the problem in a negative way, by selling his cows and trying to turn his attention to other lines of agricultural industry."

Many other writers are of the same general opinion, although few of them express their convictions in such a strong statement as does Professor Lindsey.

As Professor Lindsey states, it is too often the case that the farmer figures only the feed cost and forgets to consider the labor and overhead expenses as costs in milk production. However, to secure a price 10 to 20 per cent in advance of all costs is not a just view of the situation. A complete account of overhead charges includes, besides other expenses such as depreciation, taxes, etc., a charge for interest on all capital invested. In a complete and properly arranged cost account the dairyman is credited with the market price of his feeds, is given a fair wage for his labor, and is paid the current rate of interest on the capital invested. If the price received for his product is

sufficient to cover all expenses, including the above charges, the dairyman is engaged in a profitable business and should not expect the consumer to pay him 10 to 20 per cent in addition to these costs. Too many of our agricultural writers have been wont to consider that, when the price received for the milk only balances the total cost, the dairyman is not making money. As a matter of fact, besides receiving the farm market price for his feeds, the dairyman is getting paid for his labor and is making a fair rate of interest on his money.

The results from the Massachusetts Experiment Station are published in Experiment Station Bulletin No. 145, a summary of which is given in Extension Bulletin No. 11 as follows:²

"The data include the results with station cows from 1896 through 1911, and were all accurately kept. The prime object of keeping the herd was to study the relative values of coarse and concentrated feeds upon milk production and also to investigate the effects of the different groups of nutrients upon the chemical character of the milk. With such ends in view it is not possible to select those feed combinations which would produce the largest amount of milk for the

least money. Nevertheless, most of the feeds used were those which would have been fed by the average dairyman. Most of the animals used were mature grade Jerseys. Later the herd contained a few Holsteins and Ayrshires and included heifers raised by the station.

"In order to make the data more applicable to present conditions, all grain was figured at an average price of \$32. per ton, hay at \$18 per ton at the barn, silage \$4.50, green feed at \$3.50, and pasture at 5 cents per day. The animals were soiled during the summer and were turned to pasture only when dry, which would naturally increase the cost somewhat. For converting pounds into quarts the average figure of 2.25 was used instead of 2.15, the extra .10 being allowed for loss in handling."

Food Consumed and Cost.

Number Yearly Records	Grain		Roughage		Total Food cost per cow
	Total cost	Average per cow	Total Cost	Average per cow	
131	\$4353.64	\$33.23	\$7336.50	\$56.00	\$89.23

Yield, Composition and Cost of Milk.

Average yearly yield per cow		Average percent- age composition		Pounds butter	Food Cost per cow	Net yearly fixed charge
Lbs.	Qts.	Solids	Fat			
6036.3	2683	14.11	5.07	356.4	\$89.23	\$55.00

Total cost per cow	Cost of milk	
	100 lbs.	1 qt. (cents)
\$144.23	\$2.39	5.38

"The food cost of a quart of milk was 3.33 cents and the cost for care and supplies, or net fixed charges (estimated) was 2.05 cents. These figures indicate that the farmer having a grade Jersey herd producing 6,000 pounds of milk per year per cow, testing 5 per cent fat should receive substantially 5.4 cents per quart for it at the farm in order to get a fair market price for his roughage and \$35 per year for his labor per cow."

The Connecticut (Storrs) Experiment Station in Bulletin No. 73 gives a complete account of the data for (1907-1911) of a dairy herd belonging to the Connecticut Agricultural College. The herd consists of representatives of the four leading dairy breeds, Jerseys, Guernseys, Holsteins, and Ayrshires. Accurate accounts

were kept of labor and other items of cost as well as the cost of the food. The following is a summary of their report as given in Experiment Bulletin No. 11 of the Mass. Agricultural Experiment Station.²

Number of cows	Average yearly produc- tion		Average per cent fat	Food cost per cow	Net yearly fixed charges
	Lbs.	Qts.			
124	6379	2835	4.34	\$84.07	\$50.00

Total cost per cow	Cost of milk 100 lbs. - 1 qt. (cents)	
\$134.07	\$2.12	4.87

The New Jersey Experiment Station (35th Report pp. 151-155) gives an account of the cost of the milk produced by its herd of 28 selected purebred and grade Holstein, Guernsey, Jersey, and Ayrshire cows for 1914 as follows:⁴

Number of cows	Average yearly produc- tion		Average per cent fat	Food cost per cow	Net yearly fixed charges
	Lbs.	Qts.			
28	7040	3120	3.47	\$95.24	\$20.19

Total cost per cow	Cost of milk 100 lbs. - 1 qt. (cents)	
\$115.43	\$1.64	3.7

Roughage and grain were figured at the market price, hay at \$20, silage \$5, and green crops \$4 per ton.

The total net fixed charges (\$20.19) are very low. According to the author "interest and depreciation on the cows are not included, as it is figured that the value of the calves will exceed the interest and depreciation." It should also be noted that the cows are selected individuals having a production much above that of the average animal.

The Cornell Experiment Station⁵ gives the results of a study of 53 herds comprising 834 cows in Jeffers County, New York, for 1912. These cows were mostly Holsteins. The following is a summary of their report:

Number of cows	Average yearly produc- tion		Average per cent fat	Food cost per cow	Net yearly fixed charges
	Lbs.	Qts.			
834	6621	2943	3.64	\$51.57	\$28.90

Total cost per cow	Cost of Milk 100 lbs. - 1 qt. (cents)	
\$80.47	\$1.21	2.72

It will be noticed that these costs are low in comparison with those from other investigations. The authors make the following explanation:⁵

"Many of the local conditions and advantages surrounding the herds discussed in this study combine to give relatively low costs. Pasture, which is one of the best and cheapest sources of nutrients, is used extensively. The general use of cheap, coarse fodders about the farm which could not be profitably marketed otherwise, together with the liberal use of farm grown grains, have materially reduced the item of feed cost. The investment in buildings and equipment is also relatively small. The labor charge, which covers care of all cows in the herd whether they completed their record or not, should be sufficient to offset any irregularities or losses incident to changing cows in so far as these changes might effect the ultimate cost of the product."

"It should be kept in mind, however, that these cows are above the average in production and consequently are more economical producers. Under conditions prevailing in other counties in the state, food costs would be doubled for the same scale of production and other costs would be increased from 20 to 40 per cent. This would make the cost of a quart of milk from the average dairy cow considerable more than the producer receives for it."

Further investigations were made by the Cornell Experiment Station⁶ in Delaware County, New York, and

include 174 herds comprising 5,308 cows in 1912 and 5,030 in 1913. These cows were mostly grades of the four leading dairy breeds, Jerseys being noticeably in evidence. The average yearly production of these cows for the two years was 4,670 pounds of 4.6 per cent milk containing 215 pounds of fat.

A summary of the costs of production for these two years as found by these investigations in Delaware County, New York, is given in the following table.

Items of cost	Cost	Per cent of total costs
Value of grain	\$31.79	27.4
Hay, forage, and silage	42.62	37.0
Pasture	4.05	3.5
Bedding	<u>.85</u>	<u>.7</u>
Total cost of feed and bedding	\$79.31*	68.6*
Annual cost of buildings	5.48	4.7
Labor cost	20.28	17.5
Interest on value of cows	2.61	2.2
Cost of dairy equipment	.47	.4
Cost of hauling milk	6.00	5.2
Miscellaneous costs	<u>1.70</u>	<u>1.4</u>
Total cost	\$115.85	100.0

*Includes feed cost of heifers to replace the discarded cows.

Total cost	\$115.85
Returns other than milk calf, manure, etc.	<u>12.70</u>
Total net cost per cow	\$103.15
Cost of 100 pounds of 4.6 per cent milk	\$2.20
Cost of 1 quart of 4.6 per cent milk	.047
Cost of one pound of fat	.48

The price received per 100 pound of 4.6 per cent milk was \$1.70 or ^{cents} .37 per pound for the butter fat. At these prices the production necessary to equal this cost would be 6,100 pounds of 4.6 per cent milk or 280 pounds of fat.

This data from Deleware County appears to have been very carefully and completely gathered and gave complete returns for over 5,000 cows for two consecutive years. However, the charges which should be listed as depreciation and taxes on cows are included in the feed costs. Most of the farmers raised enough heifers to keep up the herd and the feed cost of these heifers was included in that of the feed cost for milk production.

The New Hampshire Experiment Station publishes the results of some investigations by Professor Rasmussen⁷. The data on which most of his feed costs are based, were

obtained from the Lindeboro Cow Testing Association. While some of the conditions were more favorable for economical production than with the average New Hampshire dairy, however, the author states that these figures are a conservative estimate on the yearly expenses entering into the production of milk on a dairy farm in New Hampshire. A summary of these costs is as follows:

Item of Cost	Cost	Per cent of total.
Feed	\$73.03	49.4
Bedding	4.00	2.7
Labor	32.33	21.9
Hauling milk	7.18	4.8
Buildings	9.05	6.1
Equipment	.53	.4
Interest, depreciation, taxes and insurance	13.38	9.1
Miscellaneous	4.44	3.0
Keep of bull	<u>3.79</u>	<u>2.6</u>
Total costs	\$147.73	100.0
Credit for manure and calf	<u>18.00</u>	
Net cost	\$129.73	

Average production was 6,463 pounds of milk.

Average test was 3.76 per cent fat

Cost per 100 pounds of milk \$2.01

Cost per quart .043

Cost per pound of fat .53

In this investigation as in all others of a similar nature it was found that there were some good cows and some poor ones. The following table shows the highest and lowest producers in three respective herds:

Herd	No. of cows	Pounds of milk	Pounds of fat	Feed Cost	Profit*	Cost of 100 lbs. milk	Cost of 1 lb. of fat
A	1	12,275	463	\$106.80	\$119.00	\$0.87	\$0.23
	2	1,540	60	44.73	-15.38	2.90	.74
B	3	9,773	351	96.21	76.28	.98	.27
	4	3,824	155	69.28	-5.15	1.81	.45
C	5	8,410	307	83.58	65.11	.99	.27
	6	4,845	227	73.83	16.44	1.52	.32

*Profit means returns above feed cost.

"Cow No. 1 equals seven like No. 6 in profit."

"Cow No. 5 equals four like No. 6 in profit."

"The cows within the same herd had the same

care and treatment. The difference in production and profit represents the difference in milking ability and capacity of the individual cows.

"Cow No. 6 represents about the average production in the state of New Hampshire. No. 1, therefore, would equal in profit seven average cows of the state.

"A comparison of No. 5 and No. 6 should be especially interesting as a great many farmers would have just such a case. Although No. 5 gave 3,565 pounds more milk than No. 6 it cost only \$9.75 more to feed her. No. 6 gave a profit above her feed of \$16.44, while No. 5 gave a profit of \$65.11 or four times as great.

"Cows like Nos. 1, 3, and 5 represent the hope and future of the dairy business, while Nos. 2, 4, and 6 represent the present despair. Cows of the former type are a source of pleasure and profit while those of the latter are a source of discontent, drudgery, and loss.

"Cows of the type of Nos. 2 and 4 are not the greatest danger to the profits and to the future of the dairy business as they are so poor that even the least observing dairyman will realize that they are unprofitable and will dispose of them. Cows of the type of No. 6 are the greater danger. The man who does not keep records of his cows assumes that such a cow is profitable

and he not only keeps her but often breeds her to an inferior bull and raises heifer calves of the same limited capacity for production and profits."

In the discussion of this investigation Professor Rasmussen states:

"From the records obtained from the Lindeboro Cow Testing Association it seems clear that a mature cow to be profitable must produce from 6,000 to 8,000 pounds of milk per year, depending upon the price obtained. Since this amount is considerable above the average production, a large number of the dairy cows in the state are apparently kept at a loss. This does not mean that the farmer has actually paid out more money at the end of the year than he has received for the dairy products sold, but it means that he has accepted an interest less than 5 per cent on his investment, in buildings, equipment, and cows; he has accepted low wages for his own labor and the labor of his family and has marketed his crops to his cows at less than the market price."

"Although the amount of milk produced per cow is not the only factor to be considered as a basis for figuring the cost of milk production, at the present time, however, it is absolutely essential for the farmer to increase the production per cow, for even with the best

management the type of cows of average production in this state cannot be made profitable."

"The factor second in importance to the individuality of the cows is the raising of crops on the farm suitable for milk production. There is no future for the dairy business in New Hampshire with timothy hay worth \$20 to \$30 per ton as roughage for dairy cows. Clover, oat and pea hay, and other roughage crops yielding large quantities of digestible nutrients per acre and having a low market value must take its place."

"Thirdly, a factor for serious consideration is the capitalization per cow. With the many new sanitary requirements for milk production there has in some cases been a tendency to provide too expensive buildings and equipment. The equipment should be as simple but as sanitary as possible. On a small dairy farm it is very easy to get the business over-capitalized as some of the necessary equipment would be sufficient for more cows than can be carried on the farm."

"Under average farm conditions and especially on the small dairy farm it is almost impossible to figure the profit of the dairy separate from the rest of the farm. A farmer may figure a loss on his dairy and still have a profit on the farm as a whole. The dairy

indirectly has been responsible for the production of maximum crops of hay and fodder and also has provided a ready market for the same."

"An increase in the fertility of the farm due to the keeping of cows, and the fact that the dairy farmer has accepted a low rate of interest on his investment and low wages for his labor has made it possible for him to produce milk at such an apparent loss."

"As shown in Table 2, page 5, better cows, that is a larger yield per cow, is absolutely essential to make a cheaper production of milk and to make the keeping of dairy cows profitable."

Thomas P. Cooper⁸ of the Minnesota Experiment Station publishes the results of an extensive survey to ascertain the cost of Minnesota dairy products. The work was started in 1902 in co-operation with three communities of farmers in typical agricultural regions of Minnesota; namely, at Northfield, (Rice County,) in southeastern Minnesota; and Marshall (Lyon County) in southwestern Minnesota; and Halsted (Norman County) in northwestern Minnesota. Each is a typical agricultural community, and represents a different phase of agricultural development and progress. In the vicinity of Northfield the farms are well developed and dairying is

the most important industry. Near Marshall, agriculture is in the transition from grain growing to live stock production, while at Halsted grain growing is the prominent feature, comparatively little attention being paid to live stock, although in the last five years considerable interest has been exhibited in dairying.

The following table shows the average area of farms, average number of cows and other cattle per farm, and average acreage per cow:

	Northfield	Marshall	Halsted	
			small	large
Average acreage of farms; acres	169.15	309.19	282.29	1,891.4
Average number of cows per farm	14.8	9.4	11.2	7.4
Average number other cattle per farm	9.9	16.8	14.1	14.3
Average acreage per cow	11.4	32.9	25.2	----

Judging from the average acreage per cow, none of these sections could be considered highly developed dairy communities.

A summary of the average annual costs per cow for the years 1905 - 1909 inclusive is as follows:

Northfield

	Costs	Per cent of total
Cash sundries	\$.75	1.2
Cash feed	3.65	6.0
Farm feed	23.85	40.0
Labor	18.66	31.0
General expense	2.53	4.2
Shelter	2.46	4.0
Depreciation	3.19	5.3
Machinery and equipment	.58	1.0
Herd Bulls	1.98	3.3
Interest on investment	<u>2.35</u>	<u>4.0</u>
Total	\$60.00	100.0

The average annual production per cow was
5,252 pounds of 3.6 per cent milk or 187.7 pounds of fat.

Cost of 100 pounds of 3.6 per cent milk \$1.14

Cost of 1 pound of fat .319

Marshall*

	Costs	Per cent of total
Cash sundries	\$.28	.6
Cash feed	1.49	3.2
Farm feed	20.33	44.0
Labor	15.01	32.5
General expense	1.97	4.1
Shelter	2.46	5.5
Depreciation	.36	.8
Machinery and equipment	.71	1.6
Herd Bulls	2.08	4.5
Interest on investment	<u>1.51</u>	<u>3.2</u>
Total	\$46.20	100.0

The average annual production per cow was 4,113 pounds of 3.9 per cent milk or 162.4 pounds of fat.

Cost of 100 pounds of 3.9 per cent milk \$1.12

Cost of 1 pound of fat .284

Halsted**

	Costs	Per cent of total
Cash sundries	\$.39	.8
Cash feeds	.48	1.0

*Included but four years 1906-1909 inclusive.

**Includes 1904.

	Costs	Per cent of total
Farm feeds	\$19.60	40.0
Labor	18.20	37.1
General expense	2.75	5.6
Shelter	2.46	5.1
Depreciation	.30	.6
Machinery	.92	1.5
Herd bulls	2.42	5.0
Interest on investment	<u>1.51</u>	<u>3.3</u>
Total	\$49.03	100.0

The average annual production per cow was 4,132 pounds of 3.9 per cent milk or 162.8 pounds of fat.

Cost of 100 pounds of 3.9 per cent milk \$1.19

Cost of one pound of fat .30

The prices at which feeds were figured are very low. The averages for the five years are approximately as follows: Hay \$5 per ton, fodder corn \$4 per ton, stover \$2 per ton, silage when fed \$1.50 per ton, barley 45 cents per bushel, oats 35 cents per bushel, corn 45 and 50 cents per bushel, bran \$20 per ton, and oil meal \$1.65 per cwt.

The production per cow is also very low, averaging but 171 pounds of fat per year.

The results of this investigation in Minnesota

are typical of what might be expected under frontier conditions. Considering the average production per cow, the costs per unit of production are a marked contrast to those under eastern conditions near the centers of population. However, even with these low costs, the average returns per cow were not sufficient to cover the costs, mainly because of the exceedingly low average production per cow. This average, however, could be considerably increased with the same cows and the cost per unit of product decreased by the more extensive use of silage and better dairy practices in general.

These costs as given by the Minnesota Experiment Station are more nearly representative of the costs of production under born-belt conditions. The prices of course are not as applicable at the present day as the per cent which each item contributes to the total cost.

Summary of Food Costs as Shown by These Investigations.

Massachusetts	Connecticut	New Jersey	New York Jeff. Co.	New York Del. Co.	New Hampshire	Minnesota
\$89.27	\$83.07	\$95.24	\$51.57	\$78.46*	\$73.03	\$23.13

*Includes feed cost of heifers.

Summary of Expenses Other Than Food Costs
for Mass., Conn., New York, and New Hampshire.

	Massac- husetts	Connec- ticut	New York Jeff. Co.	Del. Co.	New Hamp- shire
Buildings	\$ 7.50	\$ 8.40	----	\$ 5.48	\$ 9.05
Interest, taxes, depreciation, and insurance	16.50	13.00	----	2.61*	13.38
Labor	35.00	33.60	\$23.12	20.28	32.33
Equipment	5.15	2.00	----	.47	.53
Bedding	5.00	5.00	----	.85	4.00
Bull cost	4.00	3.00	----	----	3.79
Hauling milk	----	----	11.25	6.00	7.18
Miscellaneous	----	----	<u>12.53</u>	<u>1.70</u>	<u>4.44</u>
Total	\$73.15	\$65.00	\$46.90	\$37.39	\$74.70
Credits:					
Manure and calf	<u>18.00</u>	<u>15.00</u>	<u>18.23</u>	<u>12.70</u>	<u>18.00</u>
Net fixed charge	\$55.15	\$50.00	\$28.67	\$24.69	\$56.70

In discussing a summary of expenses other than food costs Professor Lindsey⁶⁴ says:

"It appears that the general expense or overhead charges per cow were not as great in New York as in New England. The apparent difference may be due to the fact that the New England figures are in part more in the nature

*Includes only interest on value of cows.

of estimates, and that more liberal allowances were made for upkeep, depreciation, labor, bedding, and the like. In New York less attention was paid evidently to the care of the cow and less bedding, dairy utensils, and ice were used.

"The writer doubts the possibility of dairy-men being able to live up to the Massachusetts dairy requirements in the way of clean cows and barns, pay present labor costs, and take into consideration the shrinkage on his cows, on the basis of \$25 per cow overhead charge. It is believed that \$50 is nearer the minimum cost."

It will be noticed that the estimates on overhead expenses by Lindsey at Massachusetts, Trueman at Connecticut, and Rasmussen at New Hampshire are all between \$50 and \$57.

Summary of Total Cost of Production.

	Massac- husetts	Connec- ticut	New Jersey	New Hampshire
Cost of 100 pounds of milk	\$2.39	\$2.12	\$1.64	\$2.01
Cost of 1 quart milk	.0538	.0478	.037	.043
Per cent fat in milk	5.07	4.34	3.47	3.76
Cost of 1 pound fat	.47	.49	.45	.53

	New York Jeff. Co.	Del. Co.	Minnesota
Cost of 100 pounds milk	\$1.21	\$2.20	\$1.15
Cost of 1 quart milk	.0272	.047	.025
Per cent fat in milk	3.64	4.6	3.8
Cost of 1 pound fat	.33	.48	.303

These figures given as the cost of production are not necessarily representative of all sections of the state in which they were taken. They may or may not represent a fair estimate for the average of the state. Those for Massachusetts, Connecticut, and New Jersey are based on the college herds, while those for New Hampshire, New York, and Minnesota are based on the results of investigations among the dairymen of the state. However, the conditions under which the college herds are kept are not materially different from those provided by good dairymen within the state. The feed costs and some other expenses may in some cases be more at the Experiment station than with other dairymen. However, this is usually offset by the higher production and more efficient management of the station herd.

One very noticeable feature, of a comparison of the cost of production in these different states, is that the variation in the cost of a quart of milk is

much more marked than the variation in the cost of a pound of butter fat. Since the food value of a quart of milk is largely dependent on the per cent of fat and solids not fat contained in it, it is unfair to make any comparison or state the cost of a quart of milk without taking into consideration the per cent of butter fat.

Most of these investigations and studies of milk prices and costs have been made in the northeastern part of the United States where dairy farming is one of the leading agricultural pursuits, and it is here that the situation is most acute. Other investigations of a rather incomplete nature have been made in various parts of the country but most of them are restricted to a study of feed costs. The work of Lindsey, Trueman, and Rasmussen indicate that feed costs represent only about one-half of the actual cost of production. Studies by Dr. Carl W. Larson⁹ at Columbia University show the net fixed charges to be about the same as those given by Lindsey, Trueman, and Rasmussen. Dr. Larson estimates the expense other than food cost to be \$75.46 under the conditions of his problem. He allows \$3 credit for calves and \$20 credit for manure, making a total of \$23 credit other than milk. \$75.46 less \$23 leaves \$52.46 as the net fixed charge.

The summary of total cost of production given
and 33b
on pages 33a shows the average cost of one pound of butter
fat to be about 44 cents. No one will question the
fact that this is more than the producer has been re-
ceiving for it. It would indicate that the dairy busi-
ness is a losing proposition and such has been the con-
clusion of most authors and investigators. However,
in spite of these conclusions, and although a great
many surveys show an actual loss in dairying, where
all costs are included, still the dairymen are usually
successful farmers and dairy sections are almost without
exception the most prosperous agricultural sections of
this country. Now there must be a reason for this. Is
it because the dairy farmers and their families work
harder and longer hours than other farmers and are more
thrifty or is it because dairying actually is a paying
business? Perhaps our investigators have failed to
give certain factors their proper consideration. At
least the various authors are not agreed on the relative
importance of the different factors involved and the
method of handling them. Even different reports from
the same experiment station have been worked out under
systems that make comparisons impossible.

In this discussion an effort is made to analyze the various items of cost and to present them in a manner that will afford the dairyman opportunity for study and comparison.

DISCUSSION AND OUTLINE OF PROBLEM

Accurate accounts of production costs are of value not only to the particular dairyman who keeps them but to the public in general by giving them a knowledge of what the milk costs the producer. Costs vary greatly and are determined by certain definite conditions. In discussing these variations in costs, Dr. Larson³⁶ says:

"It is no more reasonable to say that it costs five cents to produce a quart of milk than to say 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 regions of Washington state or in New York City, 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 butter fat 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 nearly all of the year for lack of pasture or whether they can be fed 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 adoption of a uniform system of accounting costs in the dairy, by the investigators and practical dairymen in various parts of the country, would enable us to make reliable comparisons of the studies in different states and localities. In reviewing the literature on the cost of milk production one finds it very difficult to make such comparisons. The need for the adoption of a standard method of cost accounting is very evident. Have we, to date, a satisfactory method which would be applicable to the various conditions under which milk is produced? It is the belief of the author that we have, in "Milk Production Cost Accounts" by Dr. Carl W. Larson of Columbia University, a very practical and

reliable method which can be applied to nearly any system of feeding and management.

The method as outlined by Dr. Larson will be used in the following analysis of the subject. The items of cost in milk production are discussed under four main divisions as indicated in the following outline:

- (1) Feed Cost.
- (2) Labor Cost.
- (3) Overhead Expenses.
 - (a) Cattle.
 - (b) Buildings.
 - (c) Bedding.
 - (d) Sire.
 - (e) Miscellaneous.
- (4) Credits other than milk which should be deducted as special credits in order to determine the net cost of the milk.
 - (a) Calves.
 - (b) Manure.

In this analysis it will be necessary for the author to pre-calculate the feed costs which at first sight may seem impractical. However, nearly

every one will agree that we have feeding standards that can be relied upon for determining the food requirements of dairy cows. Therefore, it is certainly reasonable to use them in calculating feed costs. The other items of cost will be calculated according to the conditions of the problem on which the feed costs are based, the main object being to present an analysis of the factors which determine the amount of these items.

COST OF FEED.

The largest, most important and most variable item of cost is the feed. It is the largest item in that it usually constitutes fifty per cent or more of the total cost. It is the most important item in that it is more often than any other a limiting factor in production. It is the most variable item because of the numerous conditions which effect it. The methods of feeding, kinds of feed used, amounts consumed, and efficiency of the individual cow all have a marked influence on the total cost of the feed.

One of the first questions that arises in the study of feed costs, is whether the feed should be charged at the cost of producing it on the farm or at the market price. If the cost of production price is used, all profits or losses on the farm as a whole will be credited to the dairy. This is not fair to either the dairy or the other farm enterprises. The dairy should be considered as an institution separate from the other farm operations and any profits or losses on the farm crops should not be credited to the dairy.

Pouli¹¹ in his studies of milk cost in Switzerland says:

"By the introduction of the market price we want to exclude the effects of variation of production cost of feeds . . . 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 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."

Concerning this question Dr. Larson³⁷ says:

"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 is small or where the dairy is distinctively a necessary part of the whole farm scheme, then perhaps the cost price should be used."

It is the opinion of the author that in most cases feeds should be charged to the dairy at the market price less the cost of marketing or in case the feeds are bought they should be charged at the market price plus the cost of delivering at the farm.

In figuring feed costs there are several important factors aside from the market price of the feed to be considered, such as;

The productive capacity of the cow which has a marked influence on the efficiency of production.

The amount and proportion of roughages or coarse feeds.

The amount and proportion of grain fed.

The amount of pasture.

The question of a balanced ration.

Feed required for maintenance and that required for milk production.

These factors are all more or less dependent on each other and hence the author will not attempt to discuss each one as a separate topic.

Methods of feeding and balancing rations are not discussed except in so far as it is necessary for use in calculating costs of feed. The Armsby Standard of Net Energy values is used in computing food requirements.

The amount of food nutrients required is dependent on two factors, namely, "the live weight of the cow" and "the amount and quality of milk produced"

Knowing these we can accurately determine the amount of

protein and energy required for maintenance as well as the amount required for milk production. This is not because all cows are equally efficient for they are not. However, cows of the same size require for maintenance practically the same amount of food nutrients and the amount of food required per unit quantity of the same quality of milk is practically the same. Such were the findings of Eckles and Reed¹² in their studies of milk production. The following are some of their conclusions:

"The digestion trials showed practically identical results."

"The real cause of the difference in production was found to be the amount of food 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 maintenance requirements and one that uses this available food for milk production."

Since the food requirements for maintenance are the same with cows of equal weight, 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. One cow producing 40 pounds of milk per day will be much more profitable than two cows, each producing 20 pounds of milk per day. This fact is of fundamental importance in figuring feed costs of a unit of milk or butter.

The high producing cow makes more efficient use of her feed because a greater per cent of it is available for milk production. This is very clearly shown in the following table¹³ in which all of the cows are of equal body weight (1100 pounds) but whose capacity for production varies from 200 to 600 pounds of butterfat per year.

TABLE I.1100 Pound Cow.

Productive Capacity		Proportion of Protein in Food Used for:		Proportion of Energy in Food Used for:	
Milk Yield Lbs.	Fat Yield Lbs.	Mainten- ance Per cent	Milk Produc- tion Per cent	Mainten- ance Per cent	Milk Produc- tion Per cent
5,000	200	42.0	58.0	60.9	29.1
6,250	250	36.5	63.5	55.5	44.5
7,500	300	32.3	67.7	50.9	49.1
8,750	350	29.0	71.0	47.1	52.9
10,000	400	26.4	73.6	43.8	56.2
11,250	450	24.2	75.8	40.9	59.1
12,500	500	22.3	77.7	38.4	61.6
13,750	550	20.7	79.3	36.2	63.8
15,000	600	19.3	80.7	34.2	65.8

As the production increased more total food nutrients were required but none of this extra food was needed for maintenance and hence it was all available for milk production. The 600 pound fat cow required just about twice as much food as the 200 pound fat cow, but produced three times as much milk and butter. Thus, while the higher producer consumes more feed than the low

producer, the consumption per unit of production is much less. Some idea of the difference in food requirements per unit of production, with cows of different capacities, may be gained from following table¹³.

TABLE 2.

Food Nutrients Required for 25 lbs. of 4% Milk or
1 lb. of Fat With 1000, 1100, and 1200 lb. Cows.

Productive Capacity Pounds of 4% Milk pounds	Capacity Pounds of Fat pounds	Pounds of Protein Required for Cows Whose Body Weights Are:-		
		1000 pounds	1100 pounds	1200 pounds
5,000	200	2.29	2.36	2.43
6,250	250	2.10	2.16	2.22
7,500	300	1.98	2.03	2.08
8,750	350	1.90	1.94	1.98
10,000	400	1.83	1.87	1.90
11,250	450	1.78	1.81	1.84
12,500	500	1.74	1.77	1.80
13,750	550	1.71	1.73	1.76
15,000	600	1.68	1.70	1.72

Therms of Energy Required for Cows Whose Body Weight Are:-				
		1000 pounds	1100 pounds	1200 pounds
5,000	200	18.45	19.18	19.91
6,250	250	16.62	16.84	17.43
7,500	300	14.80	15.18	15.77
8,750	350	13.76	14.20	14.59
10,000	400	13.00	13.34	13.70
11,250	450	12.37	12.70	13.02
13,500	500	11.88	12.17	12.46
13,750	550	11.48	11.75	12.00
15,000	600	11.15	11.40	11.64

As the production is increased the factors of maintenance and difference in body weight become relatively less important in their influence on the economy of feed costs. This is shown by the difference in food requirements of a 200 pound fat cow and a 300 pound fat cow as compared with the difference in the food requirements of a 500 and a 600 pound fat cow. In each case the difference in total production is 100 pounds of fat.

TABLE 3.

Productive Capacity of Cow	Food Nutrients Required for 1 Pound of Fat (1100 lb. cow).	
	Pounds Protein	Therms Energy
200 pounds fat	2.36	19.18
300 pounds fat	<u>2.03</u>	<u>15.18</u>
Difference	.33	4.00
500 pounds fat	1.77	12.17
600 pounds fat	<u>1.70</u>	<u>11.40</u>
Difference	.07	.77

Thus we see that an increase in production from 200 to 300 pounds of fat would have a much greater influence on the food cost of a unit of production (1 pound of fat) than an increase from 500 to 600 pounds.

Advanced Registry records and investigations by Agricultural Experiment Stations⁷⁵ have shown us that within the breed the higher producers are as a rule above the average size of the breed which they represent. This increase in body weight also means an increase in maintenance requirements. However, with high producers it is a factor of little importance when considered on the basis of food required for one pound of fat. The preceding table shows that for cows producing 600 pounds of fat per year, the difference in food requirements for 1000, 1100, and 1200 pound cows is so slight that it would hardly be worth considering in figuring a ration for the three cows. A graphic illustration of these points is shown in Plates I, II,

Pounds of Protein for 25 lbs. of 4% milk
or one pound of fat.

Plate I.

245 lbs.

240

235

230

225

220

215

210

205

200

195

190

185

180

175

170

165

200 , 250 , 300 , 350 , 400 , 450 , 500 , 550 , 600 lbs of
fat per
cow per
year.

Therms of Energy for 25 lbs. of 4% milk
or one pound of fat.

Pintail

The amount of roughage that a cow will consume depends largely upon the size of the cow and upon the kind and quality of roughage used and to some extent upon the grain which is fed. It is usually most economical to feed a cow all the roughage she will consume. However, except for cows of a very limited capacity for production, roughage alone will not give a maximum yield of milk. A cow must have some concentrates in her ration. It is true that many cows are fed little grain and must depend almost entirely upon roughage for maintenance and milk. However, such cows, even though they may have the ability, fail to show a large production because they can not consume and digest enough food, entirely in the form of roughage, to supply the food nutrients necessary for a maximum production. When good silage and alfalfa hay are fed a very fair milk yield may be obtained. This can hardly be said of any other combination of roughage alone, mainly because cows will eat more alfalfa than other kinds of hay. Good feeders have found it advantageous to feed some grain in addition to even the best kinds of roughage, except possibly for a short time in the summer when the cows are first turned out to grass.

A cow will usually consume about 2.5 to 3.5 pounds of silage for each 100 pounds live weight, and in

addition to the silage, about .5 to .8 pounds of hay per 100 pounds live weight. The quality of the roughage will have much to do with the amount consumed.

Concentrates or grain feeds are used to balance the roughage, and hence the nature of the concentrates will depend on the roughage fed. It is desirable to feed the grain in proportion to the milk yield, permitting the cows to vary the amount of roughage which they eat in accordance with their appetites.

"Professor Rasmussen³⁸ found in comparing the cost of roughage with that of grain with cows producing 7,000 pounds of milk or over, the cost of grain exceeded that of roughage; while with cows giving less than 7,000 pounds of milk the cost of roughage exceeded that of grain."

One of the most important items of feed cost is the pasture. It is often the determining factor as to whether a farmer shall pursue summer or winter dairying. The extent to which pasture can be used is dependent largely upon the climate and the value of the land and to some extent upon the available labor. A greater part of the dairy cows in this country are supported almost entirely for 4 to 6 months of each year from the grass crop. In many instances some supplementary feed,

usually grain, is fed and this has been found to be a profitable practice. However, the amount of grain fed is usually much less than when the cows are on other roughage.

Concerning the economy of pasture Warren¹⁴ 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, and grain 12 to 15 cents. A good pasture will replace all of the hay 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. Cooper³⁹ suggests \$1 per month, Woll¹⁵ \$5 per season, Rasmussen⁴⁰ 25 cents to \$1 per month, Thompson⁴¹ \$4.29 per cow and accompanying stock for the season, Lindsey⁴² 5 cents per day and Hooper and Robertson⁴³ \$1 to \$1.50 per month.

Most of these figures represent the prevailing charges in the communities where the investigations were made. At these prices pasture is by far the cheapest feed we have. Also the labor cost is correspondingly low when cows are on pasture. Since feed and labor are the two main items in the cost of production we readily see the importance of pasture in the economy of

production and also the importance of indicating in cost records the extent to which pasture was used.

Woll¹⁶ states that good pasture will supply about 8 to 10 feed units per day, one feed unit representing the equivalent in feeding value of one pound of corn. Therefore with corn worth \$1.50 per cwt. or $1\frac{1}{2}$ cents per pound and other feed prices in accordance, it might well be said that good pasture is worth 12 to 15 cents per day or \$3.60 to \$4.50 per month. However, high producing cows are not able to get enough feed from pasture to maintain a very heavy milk flow and some concentrates must be fed in addition to the pasture. Woll⁴⁴ showed by figures that the cows in the Wisconsin contest derived from 16 to 20 per cent of their total feed units for the year from pasture and his charge was \$5 per season. Perhaps this represents the actual cost but it is obvious that the pasture was really worth much more than \$5.

It is the practice of some dairymen, especially under frontier conditions, to underfeed the cows during the winter season, depending upon stored-up energy accumulated by the cows when on pasture to carry them thru the winter. This is primarily summer dairying and under such conditions the pasture would furnish an

even greater part of the feed for the year than was the case in Woll's studies. The data used in this discussion are based on year-round production.

Pasture land may be divided into two classes (1) permanent pasture land that can not be tilled or land that for some other reason must be kept in permanent pasture, (2) land that can be used for other crops.

In the past it has been customary to figure pasture at the prevailing charge in the community. This may or may not be sufficient to make the pasture land a profitable investment. In general, there are two ways of figuring pasture costs. One is by fixing a charge sufficient to cover expenses and interest on the money invested in the land. This seems very satisfactory for permanent pastures. However, with land that could be tilled it may perhaps be a better method to base the pasture charge per acre on the net return it would make in hay.

Since most of our pastures are more or less permanent ones, the former system of calculating pasture costs will be used in this discussion.

The first consideration in figuring a correct charge for pasture would be to determine the number of acres needed per cow and the months that the cow will be kept on pasture. The land rental charge per acre should

be based on the interest on the value of the land plus the general expense, which includes taxes, repairing of fences, reseeding, and fertilizing.

Six per cent is the interest charge used in this paper and pasture land is valued at \$50 per acre. General expenses will average about 75 cents per acre⁴⁵. The average \$50 pasture land will support about one cow on two acres for five months. Under these conditions the pasture charge would be as follows:

Interest (\$50 at 6 %)	\$3.00
General expense	<u>.75</u>
Cost per acre	\$3.75
Cost per cow (two acres per cow)	\$7.50

The cost of pasture for the season would be \$7.50 or \$1.50 per month for five months.

During some of the months the pasture may furnish practically all of the cow's feed and hence would be of more value than when it is necessary to use supplementary feeds. Therein is the chief objection to using the same pasture charge for each month of the pasture season. A definite charge per season is more satisfactory. However, where the dairyman wishes to figure his costs each month, as is the case in cow testing association accounts, a monthly charge must be used. A study of

cow testing association records in different parts of the county shows that \$1.50 per month is the charge most commonly used.

Since the food requirements for a cow can be determined from our feeding standards it is reasonable to use these standards as a basis for calculating feed costs. The main difficulty with this method is that the amount of food secured from pasture can not be accurately determined. This, however, is not serious when we know the time that the cows are on pasture and the amount of supplementary feeds that are fed.

The material presented in the following tables is the basis of the calculations which will be given on feed costs.

TABLE 4.

Maintenance Required for Cows.

			Pounds of Digestible Protein	Therms Net Energy
750	pound cow requires for maintenance		.4	4.95
1000	pound cow	" " "	.5	6.00
1250	pound cow	" " "	.6	7.00
1500	pound cow	" " "	.65	7.90

TABLE 5.

Requirements for Milk Production
in Addition to Maintenance¹⁷.

Per cent of fat in Milk	Digestible Protein per pound of milk	Therms Energy per pound of milk
3.0	.05	.26
3.5	.052	.28
4.0	.055	.30
4.5	.058	.33
5.0	.062	.36
5.5	.066	.40
6.0	.070	.45
6.5	.075	.50

TABLE 6.

For the Exact Calculation of Individual Rations.

Digestible Protein and Energy Values per 100 Lbs¹³.

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
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
Mangelwurzel	.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	4.53	72.05
Oats	8.36	66.27
Pea Meal	16.77	71.75
Rye	8.12	81.72
Wheat	8.90	82.63

TABLE 6 (Continued)

Feeding stuff	Digestible true Protein pounds	Energy value therms
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	21.56	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 (flour)	12.79	77.65

In figuring feed costs the author will assume that he has a herd of cows which average 1000 pounds live weight and whose average yearly production is 6,250 pounds of 4 per cent milk, or 250 pounds of butterfat. This is considerable above the average production of the cows that are being milked in the United States. However, it is not the purpose of the author to attempt to present average conditions from all parts of the country. Averages reflect practice, usage, and returns from the group but do not reflect the results that may be obtained with good cows and proper management.

A production of 250 pounds of butter fat per year is not at all excessive. Cow testing associations in dairy communities often show an average production of 250 pounds of fat for all cows in the association, while many cows exceed that figure. However, 250 pounds of butter fat is considered a good herd average and is a representative figure for our better dairy herds.

The first step in calculating feed costs is to determine the amount of protein and energy required by the cows. Reference to Tables I and 2 show that the needs for 365 days of a 1000 pound cow producing 6,250 pounds of 4 per cent milk to be as follows:

	Pounds Protein	Therms Energy
Maintenance (.5 x 365)	182.5 (6 x 365)	2190
6,250 pounds of 4% milk (.055 x 6,250)	<u>343.8</u> (.3 x 6,250)	<u>1875</u>
Total requirements	526.3	4065
Average requirement per day	1.44	11.14

Now let us assume that the available roughages are corn silage and mixed hay. The cows will consume about 3 pounds of silage and .7 of a pound of hay per 100 pounds live weight. For a 1000 pound cow this would be 30 pounds of silage and 7 pounds of hay per day. The protein and energy contained in this roughage is computed from the analysis given in Table 3.

	Pounds Protein	Therms Energy
Amount needed per day	1.442	11.14
30 pounds of silage	.264	4.97
7 pounds of hay	<u>.259</u>	<u>2.38</u>
In roughage	<u>.523</u>	<u>7.35</u>
To be supplied in grain	.919	3.79
Nutritive ratio of grain	1	: 4.1

Now from Table 3 we can select a grain ration that has a 1 : 4.1 ratio of protein to energy. Such a ration would be supplied by the following mixture:

	Protein	Energy
250 pounds of corn	17.5	220
200 pounds of cottonseed meal	70.0	168
300 pounds of distillers' grains (corn)	<u>66.0</u>	<u>237</u>
750 pounds of grain mixture	153.5	625
100 pounds of grain mixture	20.5	83.3
Nutritive ratio	1	: 4.1

These feeds make a good milk ration at a minimum cost. Corn is the cheapest source of energy and cottonseed meal the cheapest source of protein. The dried distillers' grains add variety and bulk to the ration at a moderate cost of both protein and energy.

The next step is to determine the amount of grain needed.

	Protein	Energy
Nutrients per day to be supplied in grain	.919	3.79
Nutrients contained in 4.5 lbs. of the above mixture	.922	3.75

Thus the cow would require an average of 4.5 pounds of the above grain mixture per day to balance the roughage.

The author will consider that, on the average, the cows receive their roughage in the stable 210 days or 7 months out of the year and get it from the pasture

155 days or 5 months of the year. Also that for about three weeks when the cows are first turned on pasture they will eat but little if any grain. Hence the cows would average a full feed of grain for 345 days.

Since the cow requires an average of 4.5 pounds of grain per day, for food nutrients not supplied in the roughage, this would be equivalent to 1 pound of grain for each 3.8 pounds of milk, except during the flush of the pasture season. (Grain to be fed in accordance to the milk yield, 1 pound of grain for each 3.8 pounds of milk)

Now to determine the total amounts of feeds consumed during the year.

Silage, 30 lbs. per day for 210 days	6300 lbs.
Hay, 7 lbs. per day for 210 days	1470 "
Grain, 345 days average of 4.5 lbs. per day	1550 "
Pasture, five months.	

The next question is, at what prices shall these feeds be figured? Prices vary greatly from one year to another and at different seasons of the year. Also there is a great variation of prices between different parts of the country. These price variations make it very difficult to express representative costs in dollars and cents.

The cost of silage will be based on the market price of corn. A 50-bushel crop of corn is equivalent in food nutrients to 10 tons of silage of the average analysis. Consider that the value of the stover is equal to the cost of husking the corn. Therefore the cost of 1 ton of silage is the market price of 5 bushels of corn plus the cost of harvesting the silage and interest, depreciation, insurance, and taxes on the money invested in the silo. These latter costs average about \$1 per ton¹⁸. On this basis the cost of silage would be as follows:

Market price of corn at the farm.					Cost of silage per ton, based on the market price of corn.
Corn	50	cents	per	bu.	\$3.50
"	55	"	"	"	3.75
"	60	"	"	"	4.00
"	65	"	"	"	4.25
"	70	"	"	"	4.50
"	75	"	"	"	4.75
"	80	"	"	"	5.00
"	85	"	"	"	5.25
"	90	"	"	"	5.50
"	95	"	"	"	5.75
"	\$1.00		"	"	6.00

The average market price of corn for the past five years has been about 70 cents per bushel which would make the cost of silage \$4.50 per ton.

It is usually considered that one ton of hay is equal to three tons of silage¹⁹. Therefore the value of hay would be \$13.50 per ton. This is a fairly representative figure for the average farm price of hay for the last several years.

Cottonseed meal is figured at \$34. per ton delivered at the farm, and distillers' grains at \$33. If corn meal were bought at the feed store as are the other grains fed, it would cost about \$30 per ton. However, we will consider that the corn was raised on the farm. Figuring corn at 70 cents per bushel and adding the cost of grinding, corn meal should be charged at \$27 per ton. Then the cost of the grain mixture would be:

250 pounds of corn at \$1.35 per cwt	\$3.37
200 pounds of cottonseed meal at \$1.70 per cwt.	3.40
<u>300 pounds of distillers grain at \$1.65 per cwt.</u>	<u>4.95</u>
750 pounds of grain mixture	\$11.72
100 pounds of grain mixture	1.56

Summarizing the feed cost, we have the following:

6300 lbs. of silage at \$4.50 per ton	\$14.17
1470 lbs. of hay at \$13.50 per ton	9.92
1550 lbs. of grain at \$1.56 per cwt.	24.18
5 months' pasture at \$1.50 per month	<u>7.50</u>
Total feed cost for year	\$55.77

It will be noticed that this estimate on feed cost is considerable lower than those given by Lindsey, Truman, Rasmussen, and others. However, where feeds were figured at the same price, this estimate on the cost of feed for a 1000 pound cow producing 250 pounds of fat, corresponds very closely to the actual feed cost of several 250 pound fat cows which the writer had occasion to observe in a cow testing association in Pennsylvania.

This method of determining feed costs requires considerable space for discussion. However, the actual calculations can be easily and quickly made, and can be applied to any system of feeding.

Since the productive capacity of the cow is one of the most important and often the limiting factor in the economy of production, its influence on cost should

perhaps be considered more fully. In discussing the dairy conditions in New Hampshire Rasmussen⁴⁶ states that a larger yield per cow is absolutely essential to make a cheaper production of milk and to make the keeping of cows profitable. Therefore, in addition to the figures given on the feed cost of a 250 pound fat cow, estimates are also given, for the purpose of comparison, of the feed cost of a cow producing 200 pounds of fat per year and one production 300 pounds.

Cow weighing 1000 pounds and producing in one year 5000 pounds of 4 per cent milk or 200 pounds of fat.

	Protein	Energy
Maintenance, 365 days	182.5	2190
5000 lbs. of 4% milk	<u>275.0</u>	<u>1500</u>
Requirements for 365 days	457.5	3690
Average for one day	1.25	10.10
30 lbs. of silage	.264	4.97
7 lbs. of hay	<u>.259</u>	<u>2.38</u>
In roughage	<u>.532</u>	<u>7.35</u>
To be supplied in grain	.727	2.75

This would require an average of 3.4 pounds of grain per day to balance the roughage. 3.4 pounds per day for 345 days would total a consumption of 1175 pounds of grain which at \$1.56 per cwt. would amount to \$181.33

Summary of feed cost for cow producing 200 pounds of fat.

Silage	\$14.17
Hay	9.92
Pasture	7.50
Grain	<u>18.33</u>
Total feed cost	49.92
Feed cost of one pound of fat	.2496

Cow weighing 1000 pounds and producing 7500 pounds of 4 per cent milk or 300 pounds of fat per year.

	Protein	Energy
Maintenance, 365 days	182.5	2190
7,500 pounds of 4% milk	<u>412.5</u>	<u>2250</u>
Average requirements per day	1.63	12.2
30 pounds silage	.264	4.97
7 pounds hay	<u>.259</u>	<u>2.38</u>
In roughage	<u>.532</u>	<u>7.35</u>
To be supplied in grain	1.107	4.58

This would require an average of 5.6 pounds of grain per day^{or} for 345 days would make a total consumption of 1932 pounds of grain which at \$1.56 per cwt. would amount to \$30.14.

Summary of feed cost for cow producing 300 pounds of fat.

Silage	\$14.17
Hay	9.92
Pasture	7.50
Grain	<u>30.14</u>
Total feed cost	61.73
Feed cost of one pound of fat	\$.206

Total Feed Costs.

200 lb. fat cow	\$49.92
250 lbs. fat cow	55.77
300 lb. fat cow	61.73

Feed Cost of One Pound of Fat.

200 lb. fat cow	\$.2496
250 lb. fat cow	.223
300 lb. fat cow	.206

Assume that the fat was sold for 40 cents per pound, then the returns for butter fat from each cow would be:-

200 lb. fat cow	\$80.00
250 lb. fat cow	100.00
300 lb. fat cow	120.00

Returns for \$1.00 Worth of Feed.

200 lb. fat cow	\$1.60
250 lb. fat cow	1.79
300 lb. fat cow	1.95

Returns above feed cost.

200 lb. fat cow	(\$80 - \$48.92)	\$30.08
250 lb. fat cow	(\$100 - \$55.77)	44.23
300 lb. fat cow	(\$120 - \$61.73)	58.27

The cow producing 300 pounds of fat per year returns practically twice as much above feed costs as does the cow producing 200 pounds of fat per year. The latter would have but \$30.08 to cover labor costs and overhead expenses whereas the former would have \$58.27 to cover said charges. The labor and overhead expenses, in fact all costs aside from feed costs, would be practically the same for each cow.

THE COST OF LABOR.

The factor of labor occupies a rather peculiar position in its effect on the dairy industry. Some men claim to have been driven out of the dairy business because of the difficulty in securing good men to work on farms where they are required to milk cows. Others claim that the labor question is one of the biggest arguments in favor of keeping dairy cows, because it enables the farmer to keep his best help throughout the year. The dairy furnishes profitable employment at times when the help could not otherwise be used. Also during the summer, when the help is most needed in the field, the cows are on pasture and require but little care aside from milking.

Possibly a very few men may be justified in stating that the labor problem forced them to quit the dairy business. However, in most cases it is an unwarranted conclusion. Labor difficulties on dairy farms are, for the most part, due to the employer. If he finds that his men are not earning the wages required to get good help, it is the management which is at fault and not the hired help.

Where the milking is considered a part of the day's work, and not an additional duty, there is less difficulty in getting good help on a dairy farm than on most any other kind of farm, because the man is assured employment throughout the year. The milking of cows is not objectionable to most hired men except when it must be done in addition to the regular day's work. Of course if a man is required to milk several cows before breakfast, then do a day's work in the field and milk the cows again in the evening, he will not be very keen for the dairy farm.

On small farms where little or no labor is hired, the farmer may be willing during the summer months to do this extra work, in addition to the regular field work, for the increase it will make in his income and also in order that he may have employment during the winter, even though the returns may not be sufficient to pay him a good wage. When cost records on these farms show a loss on the dairy, it usually means that the labor is performed at a lower wage than the figure used in the cost account.

Also in some cases the women and children do the milking and care for the cows, especially during the summer months when the farmer is busy in the field.

Much of the labor about a dairy is not very heavy work as compared with that in the field and can be done very efficiently by the boys who are not old enough to take their turn in the field. But here again, as is the case with the hired man, the boys should not be required to put in long toilsome hours in the field and in addition have to care for the cows. Concerning child labor on the farm Dr. Larson⁴⁷ says:

"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 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 discourages the boys from remaining on the farm. On the other hand, when good cows are kept, in convenient, comfortable barns and when the caring for them is considered a part of the day's work, or better still when the time is spent solely in caring for the cows, the work in the dairy is not objectionable to most boys."

Labor costs expressed in dollars alone are of limited value. A statement of costs should include

the hours of labor required per cow and the wage at which this labor is figured.

The system of management, equipment, quality of milk produced, and number of cows kept are the important factors in determining the labor requirements per cow.

If the cows are kept in the stable all of the year more labor is required than if the cows are on pasture several months. Labor costs are lowest when the cows are on pasture.

A well equipped, convenient dairy barn will materially lessen the labor per cow by enabling the men to accomplish more work with the same labor. Also the work will be more pleasant.

High class or certified milk requires the producer to use extra labor in keeping the cows and barns clean and special care must be taken of the milk after it is drawn from the cows.

The number of cows in the herd is a factor of considerable importance. This does not materially affect the labor per cow required for milking. However, there are certain operations, such as feeding, cleaning of stables, driving cows to and from pasture, etc. which

require less labor per cow in a large herd than in a small one. From the standpoint of actual time required per cow the larger dairy is the more efficient. Where the labor used in the dairy represents extra help hired essentially for that purpose, it costs less for labor to increase the number of cows up to a point where one man can devote all of his time to the dairy. A man who spends all of his time with the cows will waste less labor and give the cows better care.

However, where the caring for the cows is done on extra time or by the children, an increase in the herd to the extent of requiring hired labor may often not be profitable. Such a case would indicate that the cows are not giving sufficient returns to pay the market price of the labor in addition to the other costs. This is apparently the condition that exists on a great many of our farms where only a few cows are kept. The farmer reasons that the labor used in caring for the cows would not otherwise be utilized and that he can therefore accept a lower wage for it. Dairying with these farmers is a side issue and while it may not give as good net returns as some other farm operations, it represents an additional income which is sufficient to induce the farmer to continue the keeping of a few milk cows.

Specialized dairy farmers, whose main income is from the dairy, find it hard to compete with this class of producers on the basis of the same grade of product. They are forced to turn their attention to the production of a higher grade of product for which they may demand a higher price.

If the product is to be consumed as whole milk greater care and more sanitary methods must be used in the production. Also there is a limit to the distance from the point of consumption at which the whole milk can be produced. The producer who is near to his market can deliver his milk in better condition than one who is far away. In the case of butter and cheese the distance from market is a factor of little importance in regard to the condition in which the consumer receives them. These facts are reflected in the price received for the different kinds of product. Butter fat in whole milk produced under proper sanitary conditions commands more money than when marketed as butter or cheese. Thus, we find the specialized dairy farmer, who is sufficiently near to market, selling his product for the most part in the form of whole milk. He can not compete with the small producer in the production of butter for the wholesale trade.

The feed, labor, and market conditions represent a combination of factors which determine the type of dairy farming pursued and the form in which the product is marketed. These variations in the type of farming constitute one of the main factors in the variation of labor costs.

Some authors figure that the value of the manure offsets the cost of the labor. However, in order for such to be the case, either the manure must receive a very high valuation or else the labor must be figured at a lower wage than one can ordinarily hire it.

Labor costs vary widely in different sections of the country and at different seasons of the year. This seasonal variation is very clearly shown by Johnson and Foard²⁰ who found that from May to October inclusive, when the cows were on pasture, the labor costs were \$7.61 and from November to April, when the cows were in the stable, the labor costs were \$16.45. Thus we see that the extent to which pasture is used influences not only the cost of the ration but also the labor cost.

Some figures given by various authors on the cost of labor are as follows:

Hooper and Robertson⁴⁸, 154.5 hours a year per cow or \$23.12. Thompson,⁴⁹ 155 hours average per cow and accompanying stock at a cost of \$20.28. Rasmussen,⁵⁰ \$32.33. Trueman⁵¹, \$33.60. Johnson and Foard²⁰, \$24.60. Larson⁵², 180 hours per cow or \$27.00.

Larson⁵² gives the following units where high grade milk is produced in large herds with convenient equipment:

Operation	Time required per day per cow.
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	<u>10 "</u>
Total	24 minutes
Labor per cow per year	180 hours.

This does not provide for care of milk and dairy utensils. Also the time allowed for milking is rather low. However, Dr. Larson states that with ordinary care some of these figures may be reduced considerably.

The author offers the following estimate which would be applicable on a well equipped dairy farm under the conditions of this problem.

A 20-cow herd would require the labor of two men about 3 hours each day for milking and care of milk. During the five months of pasture season about 1 hour additional labor would be required by one of the men. During the other seven months it would be necessary for one of the men to devote practically all of his time for a ten-hour day to the cows. This does not include the labor required for the accompanying stock. The total hours of labor per year for the 20 cows would be 3,800 hours, or 190 hours per cow. At \$1.50 per day, without board, the labor cost per cow would be \$28.50.

Another factor which may be of considerable importance on labor costs in the future, in a herd of 15 or more cows, is the milking machine. There are several kinds on the market today which appear to be giving good satisfaction. In the hands of good men the milking machine gives very good results both in its effect on the cow and on the cleanliness of the milk. It should be a big help in solving the labor problem of the specialized dairy farmer.

The labor costs per cow are the same for each cow in the herd. However, this does not mean that the labor per unit of product is the same. It takes practically no longer to milk a cow giving 30 pounds of milk than it does to milk one giving 20 pounds. Neither does it require any more time to feed and care for the cow giving the larger amount of milk. Hence the high producer is again the most economical producer on the basis of the labor cost, as well as the feed cost, of a unit of product.

COST OF CATTLE.

The charge for cows should include depreciation and interest, taxes, and insurance on the valuation of the cows as milk producers. An extra value which the cow may have as a breeding animal is not to be considered in milk production costs. The breeding of purebred animals is another proposition and any additional items, which may be due to the profits or losses derived from it, should be figured in a separate account.

Since the amount of the charge for cattle is largely dependent on the valuation of the cows, the first question is what basis shall be used for this valuation. Should we use the price which one would have to pay if buying the cattle on the market or should we use the cost of raising? The logical procedure would be to use the production cost if raised by the dairyman or the purchase price if bought. If the cost of raising a cow is less than the purchase price of cows of the same grade, the advantage of the former method is apparent. However, it often happens that cows can be bought for less than the cost of raising

them. But, even if such is the case, the danger of introducing disease and other disadvantages are sufficient for one to question the advisability of such a practice in permanent dairying. The only practical way to maintain and increase the health and productive capacity of a herd of dairy cows is by the use of a good sire and raising the heifer calves from the best cows. Therefore, in this discussion the production cost of a cow, when raised by the dairyman, will be used as a basis of her valuation.

Hayden²¹ of the Ohio Experiment Station gives one of the most complete accounts of the cost of feeding and care of dairy heifers. His data includes records on 37 calves, 24 Jerseys and 13 Holsteins, from birth to time of calving at 26½ months. The following are the average amounts of feed consumed per head by these heifers.

Whole milk	459 pounds
Skimmilk	3,330 "
Grain	1,170 "
Silage	4,042 "
Hay	2,171 "
Stover	463 "
Pasture	322 days

Hayden figures the cost of this feed at \$65.30.

His charges other than feed for two years are as follows:

Value at birth	\$ 5.00
Cost of labor	11.50
Bedding	4.50
Service fees	1.50
Tools, etc.	1.50
Housing	4.00
Interest and taxes (6%)	<u>4.68</u>
Total fixed charges	\$32 .68
Credit for manure	<u>9. 00</u>
Net cost for two years	\$23.68
Net cost for 26½ months	<u>26.09</u>
Cost of feed	<u>65.30</u>
Total cost at 26½ months	\$91.93.

Bennet and Cooper²² give the following material on the cost of raising dairy heifers:

Average amounts of feed consumed during
the first two years:

Whole milk	342 pounds
Skimmilk	3165 "
Mixed hay	1977 "
Corn silage	3602 "
Grain	547 "
Corn stover	672 "
Pasture	294 days

These figures are given for 24 months while those given by Hayden are for $26\frac{1}{2}$ months. When this difference in time is taken into consideration, the amounts of feed consumed correspond very closely except for the grain and milk. Hayden's heifers consumed about 100 pounds more of whole milk, 200 pounds more of skimmilk, and twice as much grain as did those given by Bennet and Cooper. Thus the feed cost of Hayden's heifers would be somewhat higher than for those used by Bennet and Cooper. The feed cost of Hayden's heifers at 24 months was \$56.32.

The labor requirements as given by Bennet and Cooper were 40 hours per heifer during the first year

and 23 hours during the second year which is also considerable less than the figures given by Hayden.

Dr. Larson⁵³ in using the material given by Bennet and Cooper figured the feed cost at \$47.51. The labor he figures at 15 cents per hour or \$9.45. The other expenses including interest, buildings, equipment, loss by death, and miscellaneous expenses amount to \$16.67.

Summary of costs as figured by Larson.

Feed	\$47.51
Labor	9.45
Overhead charges	<u>16.67</u>
Total	\$73.63
Credit for manure	<u>8.00</u>
Net cost	\$65.63

This does not include the initial value of the calf at birth.

Trueman³³ of the Connecticut Experiment Station and Lindsey³⁴ of the Massachusetts Experiment Station figured the cost of a two year old heifer to be \$70 and \$74.24 respectively. Each allowed \$4 as the value of the calf at birth. Hayden's figure for the total cost at two years is \$80.

If the heifers freshen at an average age of 24 months, the cost at two years of age would be the proper valuation. However, experience has shown that it is advisable to have the heifers more fully developed when she drops her first calf. An average age of 26 to 28 months is to be preferred over 24 months, depending mainly upon the breed in question as some breeds mature earlier than others.

Hayden's heifers cost \$80 at two years of age. Their cost at time of dropping their first calf was \$91.93, an increase of 15 per cent. If we add 15 per cent to the costs at two years as figured by Larson, Trueman, and Lindsey we have the following costs at 26½ months of age:

Larson	\$75.47
Trueman	80.50
Lindsey	85.38

These figures represent more nearly the actual cost of raising a dairy heifer than the cost at two years of age. They are the most representative ones that can be obtained and may be used as a guide to cost estimates.

Any statement of costs will only be applicable under the conditions on which the costs were based. However, the above estimates are all based on accurate cost accounts and probably correspond very closely to the actual cost of raising a heifer on a dairy farm. In this discussion on the charge for cattle, the cost of heifers to first calving will be placed at \$80. This figure is arbitrary and may be varied according to the conditions under which the heifer is raised, age at calving, etc.,

Having determined the valuation to be placed on a heifer when she comes into the herd as a milk cow, the next question is how long will she remain in the herd as a profitable producer and what will she be worth at the end of this period. The length of usefulness varies greatly with individual cows and to some extent with the system of management and the standard of production necessary for profit. A cow may be profitable with one dairyman under his conditions whereas the same production with another dairyman would be unprofitable.

Estimates of different authors vary from four to seven years as the average life of a cow in the dairy herd. According to Rasmussen⁵⁴ it is about six years.

Investigations by the United States Department of Agriculture²⁴ show that the dairy cows of Cherter County, Pennsylvania remained in the herd 4.34 years, while in Lenawee County, Michigan they remained in the herd 4.52 years. Thompson⁵⁵ reports that in Delaware County, New York, actual records show that the average productive life of a cow was only 3.6 years, while a survey of 174 farmers in the same county shows an average estimate of 5.8 years. Dr. Larson⁵⁶ found that in 52 cow testing associations reporting 13,856 cows, the average^{age} of entry was $2\frac{3}{4}$ years and the average age of exit 7.6 years, so that the average length of time in the herd as milk producers was $4\frac{17}{20}$ years. He concluded that on the average a cow will have to be replaced every five years, which is probably the most representative figure that can be obtained, and the method used by Dr. Larson in securing this figure is a most practical and reliable one.

Of the many factors which shorten the economic life of a cow, death accounts for but one to two per cent, udder trouble, failure to breed, disease (mainly tuberculosis and abortion), accidents, and lack of producing ability are the main causes which tend to

shorten the cow's usefulness as a milk producer. Most of these troubles seldom render an animal useless for meat and she can be sold to the butcher. The sale price of discarded cows, including heifers which do not prove to be profitable producers, will vary greatly according to the breed and individuality of the animal and also according to the locality in which the dairyman is situated. Probably $4\frac{1}{2}$ cents per pound is a fair estimate of what the dairyman may expect to receive. This would make the discard price of a 1000 pound cow \$45.

The depreciation per year would then be, the initial cost less the discarded price, divided by the number of years of usefulness as a milk producer. The initial cost was \$80, and the discarded price \$45. Average period of usefulness 5 years. Therefore, \$80 less \$45 equals \$35, and \$35 divided by 5 equals \$7 annual depreciation per cow.

Some of the heifers which do not prove to be profitable would be sold at the end of the first lactation period if not before, while others of the highest producers might remain in the herd as profitable animals for eight to ten years. The method used by Dr. Larson of determining the number of years which a cow

remains in the herd, that is the difference between the average age of entry and average age of exit, accounts for the heifers which are found to be unprofitable. These unprofitable heifers are classed with the discarded cows and their sale price should be considered in determining the average discard price.

It is maintained by some authors that since most of these unprofitable heifers must be sold for less than the cost of producing them, the loss on such heifers should be added to the cost of the profitable ones, because, provided the heifers have the same quality of breeding, it is necessary to raise all of them to a producing age before any distinction can be made. In practice this is what actually happens if all of the cows are put on the market, the good producers bring more than their production cost while the poor ones must be sold at a loss. However, in cost determination for the permanent dairyman, a system of that kind would complicate the method to such an extent as to make it more difficult for the dairyman to keep his accounts. The method advanced by Larson accounts for this loss in the depreciation per cow and is a more simple and practical system of cost records. The valu-

uation placed upon the heifer when she enters the milking herd represents her cost of production. If she does not prove to be profitable and must be sold at a loss, this loss is considered as her depreciation in value and is accounted for in the average depreciation per cow.

This system may also be used where the milk cows are bought or where part of them are bought and part are raised by the dairyman. He should keep an account of the age and cost of the cows at entry into the milking herd, whether the cows are purchased or raised. He should also keep a record of their age of exit and the price received. From these accounts he can accurately determine the correct charge for depreciation under his conditions.

The other charges in the cost of cows are interest, taxes, and insurance. Interest is charged at 6 per cent, taxes at 2 per cent when assessed at one-half value, and insurance against loss from fire and storm 3 per cent. If the charge of depreciation is made against the cow each year and she is required to pay this charge, these other charges should be based on the initial cost of the cow only during the first year. The inventory value of the cow would be decreased

\$7 each year and would be \$80, \$73, \$66, \$59, and \$52 respectively for the five successive years during which the cow is in the herd. This would make her average inventory value for the five years \$66, which represents the valuation that should be used in figuring interest, taxes, and insurance.

The total cost of cows per year would, therefore, be as follows:

Depreciation	$\frac{\$80 - \$45}{5}$	\$7.00
Interest - \$66 at 6 per cent		3.96
Taxes - \$33 at 2 per cent		.66
Insurance - \$66 at .3 per cent		<u>.20</u>
Total annual cost per cow		\$11.82

This annual cost per cow would be the same for a high producing cow as for a low producing one. Of course if bought on the market the high producer, provided her ability is known, would cost more money. On the other hand, because of her greater ability as a milk producer, she would remain in the herd as a profitable cow for a longer period of time than her stable mate of less capacity, which fact would lower her individual depreciation per year, probably to the extent of more than enough to counterbalance any difference

in the purchase price.

Since the charge per cow, in this item on cost of cattle, is practically the same whether the cow is a good or poor producer, the cost per unit of product would decrease with a higher scale of production.

COST OF BUILDINGS.

In figuring cost accounts for the dairy herd, some charge should be made for the buildings in which the cattle are stabled. This charge may be considered as rent for the use of such buildings, and should include interest on the investment, taxes, insurance, repairs and depreciation.

On most farms we will find the cows stabled in a barn which also serves as a storage barn for hay and grain. Since the main purpose of the barn, aside from stabling the cows, is to serve as a storage for the cows' feed, we find that most authors charge practically the entire cost of such buildings to the dairy. If the price charged for hay is the purchase price during the harvest season, the storage cost should be included in this item on the cost of milk production. However, in this paper, the feeds were figured at the market prices which included all storage costs. It is necessary to have a barn in which to store the hay for market even if it were not fed to the cows. Therefore, the cost of storage is taken care of in the item of feed costs and should not be included in the cost of buildings

for the dairy.

The question now arises, what portion of the cost of the building or buildings should be charged to the dairy. That must be decided by each individual dairyman according to his own conditions. The most logical method of obtaining an estimate on the proper charge for buildings would be to base all calculations on the cost of a stable separate from the storage barn. If the two are built together then the extra cost above that of the stable itself represents the cost of the portion used for storage.

The unit cost of a barn for dairy cows will vary greatly, depending upon the type of barn built, the material used in construction, equipment for convenience and sanitary conditions, and number of cows in the herd.

The type of barn which the dairyman would build is largely dependent on his climatic conditions. In the colder parts of this country it is quite necessary to provide a very substantial stable, while in the warmer climates an open shed may be sufficient. Thus any statement of building costs is only applicable under conditions similar to the ones on which it is based.

The use of more permanent material such as stone, cement, and hollow tile is becoming more popular

in recent years. The initial cost is somewhat more than for a frame barn, however, the repairs, depreciation, and danger from fire are considerably reduced. Concrete floors are very desirable from the standpoint of sanitation and for the purpose of conserving the liquid manure. The portion of the floor on which the cow stands should be covered with cork-brick or something of that nature in order to make the animals more comfortable and to lessen the danger of garget which might be caused by contact of the cow's udder with the cold cement. Cork-brick floors also require less bedding and in some sections of the country this saving alone is sufficient to warrant the additional expense. The interest charge on well constructed buildings of permanent material will be comparatively high because of the higher initial cost, but the expense for repairs and depreciation will be at a minimum.

The number of cows in the herd is an important factor in the unit cost of buildings. The cost per cow is less in a 40-cow barn than in a 20-cow barn of the same construction.

All of these conditions and some others may enter to cause variations in the annual charge for buildings.

Larson⁵⁷ figures that a 50-cow barn of modern construction and equipment throughout can be built with such material as hollow tile or concrete for about \$80 per head. "This is for a good barn with proper ventilation and modern sanitary arrangement, for a specialized dairy capable of meeting all the requirements for the production of high grade milk." On this basis he figures the total annual cost of buildings to be \$8.24 per cow in a 50-cow herd. Rasmussen⁵⁸ places the cost of housing at \$9.05 per cow. Under housing is considered the cow barn, barn for storage of feed, silo, and places for handling and storing the milk. From estimates of buildings of the members of the Lyndeboro Cow Test Association this part of the equipment was valued at \$2,000 for 20 cows. Rasmussen places the feed storage costs in the item of cost of buildings, rather than adding it to the price charged for the feed. Lindsey⁵⁹ of Massachusetts places the charge for barns at \$7.50 per cow. Trueman of Connecticut⁶⁰ at \$8.40. Based on the results of a survey of Delaware County, New York, Thompson⁶¹ makes a charge of \$5.50 per cow for buildings.

The cost of a stable to accommodate a milking herd of 20 cows and the accompanying stock would be about \$2,400, two-thirds of which should be charged to the

milk cows. This estimate is sufficient to build and equip a barn for the production of grade (A) milk. Very few of our dairymen are producing grade (A) milk and their cows are housed in less expensive barns than the kind just mentioned. However, most of our dairy barns could be equipped for the production of a first class sanitary product without much extra cost per cow. The main additional expense in the production of high grade milk is the extra labor required.

That portion of the barn, occupied by the milk cows on the average dairy farm, equipped for the production of good sanitary milk, should not exceed \$60 per cow in a 20-cow herd and this is the figure which will be used in the following estimates.

Interest is figured at 6 per cent, the same as in the cost of cattle. Taxes at 2 per cent when assessed at one-half value and insurance at .3 per cent. Depreciation and repairs are figured at 5 per cent.

On this basis the yearly charges for buildings per cow would be as follows:

Interest - \$60 at 6 per cent	\$3.60
Taxes - \$30 at 2 per cent	.60
Insurance - \$60 at .3 per cent	.18
Depreciation and repairs - \$60 at 5 per cent	<u>3.00</u>
Annual cost of buildings per cow	\$7.38

COST OF BEDDING.

The charge for bedding, while not very large in proportion to some other costs, is one which varies greatly in different sections of the country. On farms where little or no grain is raised aside from the corn, the problem of securing bedding may be one of considerable importance. On grain farms, with a small dairy some distance from the city, the charge of bedding may be practically nothing because there is no market for the straw. However, when located where the straw can be sold at a profit or where it must be bought, some charge must be made for bedding.

Straw is the most common bedding material but a great many substitutes are now being used in dairy herds, sawdust and shavings being the most common. These substitutes, especially on farms where high grade milk is produced, have the distinct advantage of not being so dusty as straw. However, their manural value is very low. If the dairyman has straw on hand he will of course use it and the charge should be whatever net returns would be received if sold on the market. If bedding must be bought, the price of the various materials

which might be used would be the main determining factor as to which kind to purchase. Baled shavings have the advantage over all other kinds of bedding in that they can be handled with less labor, are relatively freer from dust, absorb liquid manure very well, and will stay where placed thereby making it possible to keep the cows cleaner. If the price is such as to make them as cheap as other materials they are much to be preferred.

The amount of the various beddings needed per year will depend on the length of time the cows are kept in the stable, whether kept in stanchions or box stalls, and the nature and condition of the stable floors.

Using the absorptive properties of the different bedding materials as given by Doane, Dr. Larson⁶² figures that when the cows are kept in the stable 24 hours per day for 8 months, the amount of bedding needed would be 1,200 pounds of wheat straw, 3,000 pounds of sawdust, or 1,050 pounds of shavings per cow. Assuming the cost of straw to be \$6 per ton, sawdust \$1.50, and shaving \$6., he got the following costs, \$3 for straw, \$2.25 for sawdust, and \$3.15 for shavings. In his statement of cost accounts Dr. Larson used \$3.25 as the

charge for bedding.

Rasmussen⁶³ states that bedding costs the farm department of the New Hampshire Agricultural College on an average of two cents per bushel for sawdust and the amount used was 200 bushels per cow, making a cost of \$4. At the New Jersey Experiment Station³⁵ the cost of bedding per year was \$5.30, using one bale of shavings for 20 cows per day. The cows, however, were kept in the stable throughout the year. Where the cows are soiled during the summer and turned out to pasture only when dry, Lindsey⁶⁵ places the cost of bedding at \$5 per cow. Trueman⁶⁶ of Connecticut also figures the cost of bedding at \$5. Thompson⁶⁷ in his report on the survey of Delaware County, New York, charges but \$.85 per year for bedding which is an exceedingly low figure.

Where accurate cost accounts have been kept, and also from the calculations made by Larson, it seems that when the cows are kept in the stable throughout the year, \$5 per cow is about the correct charge for bedding. In this problem the cows are on pasture for five months of the year during which time there is no expense for bedding. The charge for the other seven months should then be $\frac{7}{12}$ of \$5, or approximately \$3, cost of bedding per cow for one year.

THE COST OF SIRE.

There is some question as to whether the charge for bull service should be included in milk production costs. It might perhaps be better to consider the cost of sire per cow as the average valuation of the calves when born. This would eliminate the two factors, namely, cost of sire and value of calf from milk production cost accounts. Since the sire is the main factor in determining the value of the calves and also since the sire has no influence on the production of the cows which he serves, the elimination of these two factors from milk costs with the present generation of cows, is quite desirable. The chief objection to such a system of accounts is that the actual value of the calf, that is the price for which it could be sold, might be less than the cost of the sire or vice versa. If the value of the calf is more than the cost of sire per cow, the value is chiefly due to the sire and perhaps, to some extent, to the ability of the cow as a breeding animal. Since no charge is made in milk production costs for the breeding value of the animal, this extra value of the calf should be credited to the breed-

ing operations rather than to the milk accounts. Now if the value of the calf is less than the cost of sire where will we credit the loss? Logically it should be credited to the breeding operations and if they show a loss it is up to the dairyman as a breeder to rectify his mistake by using a better sire.

Not every one will agree with the author in this procedure. It is maintained that since it is necessary for the cows to become pregnant and give birth to a calf in order for her stimulus for milk production to be renewed, the cost of sire is a legal charge in production costs. The calf may then be credited at whatever it is worth. This will work very well if the value of the calf just balances the cost of the sire. However, since the value of the calf is mainly determined by the breeding, it hardly seems fair to credit any profit or loss on it to the cost of producing milk with the present generation of cows.

There is another way of considering these factors, and that is as we ordinarily find them on a great many of our dairy farms. The calves are disposed of as soon as the cow's milk is fit for human consumption at whatever they are worth for bob-veal and almost any kind of a sire is used. This is of course not good breeding practice. It eliminates, however, the factor

of breeding and when considered on this basis the cost of the sire and value of the calf should both be figured in an account of milk costs.

The foregoing discussion, as presented by the author, is mainly for the consideration of purebred breeders. By eliminating the cost of sire and value of calves, the problem of figuring milk costs in a purebred herd is no more difficult than in a herd of grade cows.

The cost of sire per cow is determined by two factors, namely, the expense of keeping the sire and the number of cows served. The latter factor is determined by the size of the herd. The former is mainly determined by the feed, labor, and some other costs which are dependent on the valuation placed upon the animal. The first question to be settled is what shall be the basis of valuation in figuring these costs. The initial cost of a bull varies from a few dollars to several thousands. When more than an ordinary price is paid for a bull it is paid for proven ability or for promise of superior ability. The expense of raising a good bull is no more than for a poor one. This extra price represents a breeding valuation which will yield returns in the value and ability of the next generation.

From the standpoint of the cost of producing milk with cows of the present generation, it is not correct to figure the cost of the sire on the basis of an expensive animal, because when a cow is born her inheritance is fixed and the sire to which she may be bred will not in the least influence the economy of her production.

A purebred bull of ordinary breeding of servicable age (about 15 months) can be purchased for \$100. This is about what it would cost the dairyman to buy a purebred calf and raise it. Such a bull should give calves equal to or better than the 6,250 pound producers used in this problem.

The expense of keeping a bull is somewhat different from that of keeping a cow. He should be kept in a box stall and have a lot in which to exercise. It is not advisable to turn him out with the cows in the summer and hence he must be fed in the stable the year around. More bedding will be required. The actual feed consumption will be less than for a cow but since the bull must be fed in the stable during the summer the cost will be nearly as much as for a cow. Aside from the time required for milking, the labor to care for a bull would be more than for a cow because he is kept in the stable throughout the year. Twenty minutes a

day should be sufficient to care for him properly. This would be a total of 120 hours per year. Taxes, interest, insurance, and cost of buildings should be figured on the same basis as in the case of cows. The depreciation will be higher than for cows because the period of usefulness is shorter. The initial cost of the bull is higher than for cows, but his discard price is also higher. On the average three years is as long as a bull can be used in one herd to advantage, except in the case of very large herds.

On this basis and assuming the initial cost of the sire to be \$100, we have the following expenses:

Feed	\$50.00
Bedding	5.00
Labor 120 hours at 15 cents	18.00
Depreciation $\frac{\$100 - \$70}{3}$	10.00
Stabling charge	7.38
Interest - \$90 at 6 per cent	5.40
Taxes - \$45 at 2 per cent	.90
Insurance- \$90 at .3 per cent	<u>.27</u>
Total cost per year	\$96.95
Credit for manure	<u>18.00</u>
Net cost per year	\$78.95

The greatest factor in determining the cost per cow is the number of cows served. With proper management in a large herd a bull may serve as many as 100 cows per year. There are very few herds, however, in which this is possible. The size of the herd considered in this problem is 20 cows. A bull could easily handle more than this number and the cost per cow might be considerably reduced by the co-operation of several neighboring dairymen in the use of one bull. Bull associations of this nature will enable the dairymen to use better bulls at less cost than would otherwise be possible. Following the above table, the net cost per cow in a 20-cow herd would be \$4.

MISCELLANEOUS EXPENSES.

The main items of cost have been covered in the preceding topics. However, there are always considerable miscellaneous expenses which will not fall under these headings. The chief one of these expenses is the cost of delivering the milk to the creamery or shipping station. This cost will vary greatly according to the distance which the milk must be hauled. Thompson⁶⁸ found the cost in Delaware County, New York to be \$6 per cow. Larson⁶⁹ figures the cost of hauling and transportation to the city to be \$18. for a cow producing 8,500 pounds of milk per year. The author is acquainted with conditions in several of the milk producing sections of Pennsylvania and Ohio, and the charge for hauling milk ranges from 7 to 9 cents per 40 quart can (85 pounds) of milk, or an average of about 10 cents per cwt. For a cow producing 6,250 pounds of milk the charge for hauling would be \$6.25. Co-operation in hauling greatly reduces the cost to the small producer.

There are some other expenses connected with the handling of milk aside from the cost of labor and the charge for hauling. During the summer ice is needed

to keep the milk cool, unless the dairyman is fortunate enough to have an abundance of cold running water in which to place the milk. The actual cost of ice per cow in Delaware County, New York was \$.50 per cow according to investigations by Thompson⁷⁰. Rasmussen⁷¹ figures the cost of ice for a cow producing 6,463 pounds of milk to be \$1.67, using 10 cents per cwt. as the valuation of ice. This estimate accounts for cooling the milk from 90°F. to 40°F. during six months of the year and 100 per cent is allowed for waste of ice. Larson⁷² makes a charge of \$1 for one ton of ice on an 8,500 pound cow. The farmer usually puts^{up} ice for home use and the charge for ice should be whatever the actual cost of harvesting and storage is to the farmer. One dollar per cow should cover this charge on most farms. Probably less than half of the dairies in this country use any ice at all in caring for their milk. However, the fact that many farmers do not cool their milk properly and are not particular about the condition in which it is delivered, is one of the big reasons why they do not get more money for their milk.

Some allowance should be made for wood and coal for heating water and steam for washing and sterilizing the dairy utensils. Fifty cents per cow is sufficient

to cover this charge.

Tools and special equipment such as combs, brushes, scales, clippers, forks, shovels, etc., constitute another expense. Ten dollars should be sufficient for the expense of specialized equipment in a 20-cow dairy, which would make a charge of 50 cents per cow. Dairy utensils, such as milk pails, strainers, coolers, cans, etc. will cost from 50 cents to \$1 per cow. Other supplies such as salt, soap, disinfectant, fly exterminator, medicine, etc. will cost about 50 cents per cow. Rasmussen⁷³ estimates these costs together with veterinary expense to be 87 cents per cow. Veterinary services are seldom required in a herd of grade cows and \$10 per year will cover this charge for a 20-cow herd.

Another incidental expense which might be added in some herds is the charge for supervisor of the cow testing association. This is usually \$1.50 per cow. The money expended for testing his cows will yield the dairyman greater returns than any other expense connected with his operations. However, since so small a per cent of our herds are being tested, this charge will not be included.

A summary of these miscellaneous costs is
as follows:

Hauling milk	\$6.25
Ice	1.00
Wood or coal	.50
Tools	.50
Dairy utensils and supplies	1.25
Veterinary expense	<u>.50</u>
Total miscellaneous expenses per cow	\$10.00

CREDIT FOR CALVES AND MANURE.

Since the charge for bull service is entered as an item of cost in milk production, the value of the calves at birth should be credited to this account. The actual market value may vary from nothing to several hundred dollars. However, for an ordinary dairy herd, such as the one on which the cost accounts of the preceding chapters have been based, calves are usually sold for veal. Under the system of cost accounts used in this discussion, any value which the calves may have above their veal price should be credited to the breeding operations.

The number of calves to be credited to the herd will average about four-fifths of the number of milk cows. Failure to breed, accidents, and death of calves are the factors which tend to keep down the normal number of calves. Some calves will be kept to replace the cows but credit will be received for their initial value in the amount on the charge for cattle. The veal price of a dairy calf when the milk of the cow becomes normal, usually four to five days, will vary

greatly according to the breed and size of the individual calf. An average of \$5 per calf is a fair sale price for the calves from 1,000 pound cows which are used in this discussion. Many dairymen will feed the calves for three or four weeks before disposing of them for veal. However, when the value of the milk is considered, the veal price of a calf at four weeks of age would not be sufficient to warrant any change in the initial credit of \$5. Four-fifths of this gives a credit of \$4 per cow for each cow in the herd.

The credit for manure depends largely upon the kind and amounts of feed and bedding used, and the length of time which the cows are kept in the stable. Because of the relative low charge for pasture and since there is no labor required for handling the manure when the cows are on pasture, the credit for manure is confined to the period when the cows are kept in the stable. The value of the manure to the individual dairyman is also largely dependent on the nature and condition of his soil, the crops grown, and the value of these crops.

The most common figure used for the value of manure per cow is \$15. Estimates by different authors vary from one-half to twice the amount of this figure.

It is usually considered that the average dairy cow produces about one ton of manure per month or 12 tons per year. Rasmussen⁷⁴ found that a cow produces on the average 13 tons of manure per year. He considers the value of this fresh manure to be \$1.90 per ton, or \$25 for the year's production. This valuation is based on the cost of mineral fertilizers required to furnish the fertilizing elements in similar amounts. Taking into consideration the cost of hauling and distributing the manure and the usual loss from leaching and fermentation, he states that it seems fair and reasonable to assume that not more than three-fifths of the original value or \$15 can be considered as a tangible asset to the farmer. The cost of applying the manure to the fields is a just charge, but it is not fair to the cow to charge her for careless methods of handling the manure. The cow should receive credit for her manure to the limit of practical methods of conserving this material. While it is very difficult to estimate the value of manure on any other basis than that of the fertilizing elements (nitrogen, phosphoric acid, and potash) contained in it, nevertheless the humus furnished by manure will, under many conditions, give it an

additional value. The method used by the U. S. Department of Agriculture²⁴ in their farm management studies is a very practical one. It is to compute the value of the manure on the basis of increase in value of crops. This, however, must cover a period of several years because manure has a cumulative effect and all of the value from an application of manure is not received until several crops have been harvested.

Although the factor of humus may often give manure an additional value, the mineral elements constitute the chief value of manure in increasing crop production. The amount of these mineral elements in the manure per cow is dependent on the kind and amount of feed and bedding used and the length of time which the cows are kept in the stable. Therefore, estimates by other authors would not be applicable to this problem. Since it is not possible in this problem to measure the value of manure by its influence on crop yield the mineral elements must be used as the basis of this valuation.

The feeds consumed during the seven months which the cows are in the stable were as follows:

6,300 pounds of silage

1,470 pounds of hay

1,550 pounds of grain (250 lbs. corn, 200 lbs.

cottonseed meal, and 300 lbs. dried distiller's grains).

1,000 pounds of wheat straw per cow was used for bedding.

The fertilizing elements contained in this feed and bedding are as follows:²⁵

	Nitrogen pounds	P ₂ O ₅ pounds	K ₂ O pounds
6,300 pounds of silage	18.9	7.56	22.05
1,470 pounds of hay	24.7	7.80	22.05
1,550 pounds of grain	69.4	20.15	10.85
1,000 pounds of wheat straw	<u>.5.0</u>	<u>1.50</u>	<u>6.00</u>
Total	118.0	37.01	60.95

Thorne²⁶ found that, in stables with cement floors, the following per cents of these elements in the feed were recovered in fresh manure; nitrogen 74.7 per cent recovered, phosphoric acid 77.5 per cent recovered, potash 87.8 per cent recovered. Sweetser²⁷ states that (1) the feces of milk cows contains 1/3 of the nitrogen, 3/4 of the phosphoric acid, and 1/6 of the potash of the food. (2) The urine contains 1/2 of the nitrogen, almost no phosphoric acid and 3/4 of the potash of the food.

Computed in per cents, 83 percent of the nitrogen, 75 per cent of the phosphoric acid, and 82 per cent of the potash in the feed is recovered in the fresh manure.

With good practical methods of handling the manure it is safe to assume that at least 70 per cent of the total fertilizing value of the feed should be present in the manure when applied to the field. Using a valuation of 20 cents per pound for the nitrogen, 8 cents per pound for the phosphoric acid, and 8 cents per pound for the potash, the fertilizing value of the feed and bedding per cow in this problem would be \$31.44. Seventy per cent of this figure is \$22, which represents the value of each cow's manure when applied to the field. From this must be deducted the cost of applying the manure, which would be about 50 cents per ton²⁸. On a basis of 8 tons, the deduction is \$4, leaving \$18 as credit to the cow.

SUMMARY OF COSTS.

Under the conditions of this problem as stated in the foregoing discussion for each item of cost, namely, for a 20-cow herd averaging 1,000 pounds live weight and producing 6,250 pounds of 4 per cent milk with feeds at stated prices, with the system of management given, and equipped for the production of good sanitary milk, we have the following amounts as actual costs and credits incident to milk production.

Total Costs.

1. Feed	\$55.77	
2. Labor	28.50	
3. Overhead Charges		
(a) Cattle	11.82	
(b) Buildings	7.38	
(c) Bedding	3.00	
(d) Sire	4.00	
(e) Miscellaneous	<u>10.00</u>	
Total costs		\$120.47

Credits

1. Calf	\$ 4.00
2. Manure	<u>18.00</u>
Total credits other than milk	<u>\$ 22.00</u>
Net cost per cow per year	98.47
Feed cost	<u>55.77</u>
Net fixed charge	\$ 42.70

Thus we have a net cost of \$98.47 for a cow producing 6,250 pounds of 4 per cent milk. Figuring 2.15 pounds to the quart, this is a production of 2,907 quarts of milk at a net cost of 3.4 cents per quart. The cost per cwt. is \$1.58. The total production of butter fat is 250 pounds, making a net cost of 39.4 cents per pound for the fat in the whole milk.

If the butter fat were sold as 28 per cent cream there would be 900 pounds of cream. 6,250 pounds less 900 pounds leaves 5,350 pounds of skim milk. At 30 cents per cwt. this skim milk would have a valuation of \$16.05, leaving \$82.42 as the cost of 900 pounds of cream. The cost of the butter fat in this cream is then 33 cents per pound. Cost of one quart of 28 per cent cream is 20 cents.

Now we will assume that this cream is made into butter on the farm. 250 pounds of fat would make 300 pounds of butter. Allowing the value of the skim-milk and buttermilk for labor and other expense of churning, packing butter, etc., we have 300 pounds of butter at a net cost of \$98.48 or 33 cents per pound.

A summary of the net cost of each unit of product is as follows:

Cost of 100 pounds of 4 per cent milk	\$1.58
Cost of one quart of 4 per cent milk	.03 4/10
Cost per pound of butterfat in whole milk	.39 4/10
Cost per pound of butter fat in 28 per cent cream	.33
Cost per quart of 28 per cent cream	.20
Cost per pound of butter	.33

RELATIVE COSTS OF PRODUCING MILK OF DIFFERENT
PER CENTS OF FAT.

The costs in this problem have been figured on the basis of 1,000 pound cows producing 250 pounds of butter fat per year from 4 per cent milk. Now what would be the difference in costs if these cows were producing 250 pounds of fat from 3 per cent milk or from 5 per cent milk? Only one item of cost would be affected and that would be the feed cost. It would require a production of 8,333 pounds of 3 per cent milk or 5,000 pounds of 5 per cent milk for 250 pounds of butterfat. By reference to pages 53 - 56 we can determine the food requirements for 8,333 pounds of 3 per cent milk and for 5,000 pounds of 5 per cent milk.

Food requirements for 1,000 pound cow producing 250 pounds of fat from 8,333 pounds of 3 per cent milk.

	Pounds Protein	- Therms Energy
Maintenance	182.5	2190
8,333 pounds of 3 per cent milk	<u>416.7</u>	<u>2166</u>
Total requirements	599.2	4356
Average requirements per day	1.64	11.93

Since the cows are of the same body weight and under the same system of management as the cows in the foregoing problem, we will assume that they consume the same amount of roughage, namely, 30 pounds of silage and 7 pounds of hay per day.

	Pounds Protein	- Therms Energy
Average requirements per day	1.64	11.93
In roughage (see page 63)	<u>.523</u>	<u>7.35</u>
To be supplied in grain	1.117	4.58

This would require an average of 5.4 pounds of grain per day to balance the roughage. 5.4 pounds per day for 345 days would total 1,863 pounds of grain which at \$1.56 cwt. would amount to \$29.06.

Summary of costs for 8,333 pounds of
3 per cent milk.

Silage	\$14.17
Hay	9.92
Pasture	7.50
Grain	<u>29.06</u>
Total feed cost	\$60.65
Net fixed charges	<u>42.70</u>
Total costs	\$103.35

Cost of 100 pound of 3 per cent milk \$1.24
 Cost of 1 quart of 3 per cent milk .02 7/10
 Cost of 1 pound of fat in 3 per cent milk .41 3/10

Food requirements for 1,000 pound cow producing 250 pounds of fat from 5,000 pounds of 5 per cent milk.

	Pounds Protein	-Therms Energy
Maintenance	182.5	2190
5,000 pound of 5 per cent milk	<u>310.0</u>	<u>1800</u>
Total requirements	492.5	3990
Average requirements per day	1.35	10.93
Average requirements per day	1.35	10.93
In roughage (see page 63)	<u>.523</u>	<u>7.35</u>
To be supplied in grain	.827	3.58

This would require an average of 4.2 pounds of grain per day to balance the above roughage. 4.2 pounds for 345 days would total a consumption of 1,450 pounds of grain which at 1.56 per cwt. would amount to \$22.62.

Summary of cost for 5,000 pounds of 5 per cent milk.

Silage	\$14.17
Hay	9.92
Pasture	7.50
Grain	<u>22.62</u>
Total feed cost	\$54.21
Net fixed charges	<u>42.70</u>
Total costs	\$96.91

Cost of 100 pounds of 5 per cent milk	\$1.94
Cost of 1 quart of 5 per cent milk	.04 2/10
Cost of 1 pound of fat in 5 per cent milk	.38 8/10

A comparison of these costs is as follows.

Cost of 100 pounds of 3 per cent milk	\$1.24
Cost of 100 pounds of 4 per cent milk	1.58
Cost of 100 pounds of 5 per cent milk	1.94
Cost of 1 quart of 3 per cent milk	.02 7/10
Cost of 1 quart of 4 per cent milk	.03 4/10
Cost of 1 quart of 5 per cent milk	.04 2/10

Cost of 1 pound of fat in 3 per cent milk	.41 3/10
Cost of 1 pound of fat in 4 per cent milk	.39 4/10
Cost of 1 pound of fat in 5 per cent milk	.38 8/10

Such a comparison is representative of conditions as we find them in actual practice. There is a very material difference in the cost of milk of different fat percentages and this should always be taken into consideration when stating or estimating the cost of milk. The difference in the cost of a pound of fat in the milk of different richness simply represents the cost of the extra skimmilk which would be available in the case of the cows producing milk with a lower per cent of fat. When given credit for the skimmilk at 25 cents per cwt. the cows with a lower per cent of fat in their milk produce a pound of butter fat just as cheaply as do the cows with a higher test, provided of course that the cows are of the same body weight and that the total annual production of butter fat is the same.

COMPARISON OF COSTS WITH COWS OF DIFFERENT
CAPACITIES FOR PRODUCTION.

The net cost per cow in the foregoing problem was \$98.47 and the feed cost \$55.77, leaving a net fixed charge of \$42.70. This net fixed charge is the same for each cow in the herd whether the production be high or low. The only cost which is materially effected by a difference in production is the feed cost. With cows of the same body weight, the cow that produces the most milk and butter fat always consumes the most feed.

Many of our farmers have been in the past, and to some extent at the present day are being lead to believe, by agricultural writers and institute speakers who should know better, that it costs no more to feed a good cow than it does to feed a poor one. This is entirely wrong and it is very unfortunate that so many of our farmers have obtained this erroneous impression. They seem to consider that if a cow is a good one she will produce an abundance of milk on the same amount of feed that a scrub consumes. This has been a great hindrance to improvements in methods of feeding. There is many a good cow in this country whose ability has been practically

wasted because she did not have the proper feed and care to enable her to use her capacity for milk production. Our farmers must be more strongly impressed with the fact that no matter how good a cow's inheritance may be she can not produce something out of nothing. Given a good cow, it is absolutely essential that she be well fed and cared for before she can reach a maximum and most economical production. By maximum production the author does not mean the forcing of a cow beyond her normal capacity. We mean rather, the highest possible production with practical systems of feeding and management. There may perhaps be some localities in this country where conditions are such that it is not most economical to feed a cow for her maximum production. However, there is seldom a case where it is not advisable to feed for the highest possible production with the feeds at hand. Just to what extent a farmer can afford to buy grain and other feeds depends upon his local conditions regarding the price of grain, price of other feeds, and price received for his product.

A cow's capacity for production is fixed by her inheritance. Whether or not this capacity is developed and utilized depends on the feed and care which she receives. In the following comparisons the author will

assume that he has three groups of cows of equal body weight whose normal capacity for production is 200, 250, and 300 pounds of butter fat per year and he will consider that these cows are properly fed and cared for under the same system of management, so that the only factor which may be responsible for a difference in costs is the productive capacity of the cow.

Assuming that the milk is sold at \$1.60 per cwt. for 4 per cent milk (40 cents per pound for fat) or its equivalent in cream or butter, we have the following as the value of the product from these cows of different capacities:

Production	Value of product
200 pounds of butter fat	\$80.00
250 pounds of butter fat	100.00
300 pounds of butter fat	120.00

**Cost With Cows Whose Average Production
is 200 Pounds of Butter Fat.**

Feed cost (see page 65)	\$49.92
Net fixed charge	<u>42.70</u>
Total costs	\$92.62
Value of milk	<u>80.00</u>
Loss	\$12.62

Cost of 100 pounds of 4 per cent milk	\$1.85
Cost of one quart of 4 per cent milk	.04
Cost of one pound of fat in whole milk	.46 $\frac{3}{10}$

Costs With Cows Whose Average Production
is 250 Pounds of Butter Fat.

Feed cost (see page 65)	\$55.77
Net fixed charge	<u>42.70</u>
Total costs	\$98.47
Value of milk	<u>100.00</u>
Profit	\$ 1.53
Cost of 100 pounds of 4 per cent milk	\$1.58
Cost of one quart of 4 per cent milk	.03 $\frac{4}{10}$
Cost of one pound of fat in whole milk	.39 $\frac{4}{10}$

Costs With Cows Whose Average Production
Is 300 Pounds of Butter Fat.

Cost of feed (see page 65)	\$61.73
Net fixed charge	<u>43.70</u>
Total costs	\$104.43
Value of milk	<u>120.00</u>
Profit	\$15.57
Cost of 100 pounds of 4 per cent milk	\$1.39
Cost of one quart of 4 per cent milk	.03
Cost of one pound of fat in whole milk	.34 $\frac{8}{10}$

On the basis of the above calculations the 200 pound cow is kept at a loss of \$12.62, while the 250 pound cow returns a profit of \$1.53 above all costs, and the 300 pound cow makes a profit of \$15.57. The 250 pound cow makes a net gain of \$14.15 per year over the 200 pound cow and the 300 pound cow gives a net return of \$28.19 per year in excess of the 200 pound cow. The average length of time that the cow remains in the herd as a milk producer is five years. Thus during the five years which these three cows would be in the herd, the 250 pound cow would make, in net returns to her owner, \$70.75 more than the 200 pound cow, and the 300 pound cow would show an increase in net returns of \$140.95 over that of the 200 pound producer. These figures represent only the increase in net returns from the milk and butter fat. They do not account for the difference in value of the offsprings from these cows, which when considered on the basis of permanent dairying is of even greater importance than the immediate increase in profit from the milk.

These costs show very clearly that the only sure way to a cheaper production of milk and butter fat is by means of higher producing cows. For the dairyman who is already using the proper methods of feeding and

management, a higher average capacity for production per cow is absolutely essential before he can lower his costs of producing a unit of product.

DISCUSSION OF COSTS AND PRICES.

The amounts of each item of cost as given in the preceeding chapters are not applicable to conditions where cows are kept mainly for the purpose of utilizing by-products of the farm crops. They represent costs of production from the standpoint of the farmers who are located in the more specialized dairy sections and with whom dairying is a major farm enterprise. The methods of determining each item of cost can be applied, however, to most any system of dairying.

The average production of all the cows in the United States is said to be about 160 pounds of butter fat per year or the equivalent of 4,000 pounds of 4 per cent milk. There are included in this average, however, large numbers of cows which could not be classed as dairy cows at all and which are not kept for dairy purposes but incidentally happen to be milked occasionally and are therefore classed as milk cows. They are the cows which are responsible for the low figure and not the cows with a predominance of dairy blood. A statement of costs will show that the costs of production with 160 pound cows are more than the value of the product.

However, one should not conclude that, since the average of all the cows in the United States is 160 pounds of fat, a majority of the milk in this country is being produced at a loss, because 160 pounds of fat is not a fair average for the cows that are being kept for dairy purposes in this country.

By reference to the preceeding chapters we can determine the food requirements and food costs at the stated prices for a 160 pound cow. If kept under the conditions of this problem the net fixed charges would be the same as that given for the higher producing cows. Figuring the butter fat at 40 cents per pound the value of the milk would be \$64. We then have the following statement for a 1,000 pound cow producing 4,000 pounds of 4 per cent milk, or 160 pounds of butter fat.

Feed cost	\$45.04
Net fixed charge	<u>42.70</u>
Total costs	\$87.74
Value of product	<u>64.00</u>
Loss	\$23.74

This is what may be expected if a dairyman attempts to produce milk under modern sanitary conditions with cows of low production, at present prices of feed

and labor. He finds that it is a losing proposition and unless he gets better cows is forced to quit the dairy business. However, as stated before, one should not conclude from this that the average dairy herd in this country is being kept at a loss to the owner. Under the conditions of this problem it is hardly possible to maintain at a profit a herd of cows whose average production is from 160 to 200 pounds of butter fat, which would mean that in most of our more intensive dairy sections such cows are without doubt unprofitable. Let us assume, however, as is often the case, that the cows produce most of this milk on pasture when feed costs are relatively cheap and are carried through the winter chiefly on stover or straw and hay which could not be sold to advantage on account of being damaged by rain, that bedding is almost a negligible item and that buildings and equipment are relatively inexpensive. The item of labor under this system would also be lower. Under such conditions the annual cost of keeping a cow could be decreased to the extent that a production of 200 pounds of fat would be sufficient to return the dairyman a profit. The above conditions are quite typical of many farms in the corn-belt and to a limited extent in many other parts of the country.

The corn-belt farmer does not receive as high a price for his dairy products as does the producer who is nearer the large centers of population but the conditions under which his milk is produced are such that his costs are considerable lower. The most profitable dairies in the corn-belt are those which are run in conjunction with other types of farming. The cows utilize rough feeds and pasture to a good advantage and give the farmer profitable employment during the winter. The dairy produce is usually sold as cream or butter and the skim-milk enables the farmer to make better and cheaper gains with his hogs or stock calves. This latter factor is one of much importance to the hog raiser as experimental results and practical observations have shown very conclusively that hogs make much more efficient use of their grain when it is supplemented with skimmilk. The extent to which it is profitable for the corn-belt farmer to take up dairying is a problem worthy of serious thought and study. Doubtlessly dairying offers excellent opportunities when combined with corn and hog farming and should receive more consideration than it has in the past.

It was found that, under the conditions of this problem, the annual cost of keeping a cow with a production of 6,250 pounds of 4 per cent milk, or 250 pounds of

fat was \$98.47. That these costs are representative of the conditions on which they are based is shown by comparison with actual cost accounts. In the April 4th, 1917, issue of the "Jersey Bulletin" is contained a summary of the costs in Trumbull County, Ohio, as shown by the Cortland Cow Testing Association. The average production per cow for the year 1916 (not figuring those on test less than four months) was 5,996 pounds of 4.04 per cent milk and 242.34 pounds of butter fat. The following is a statement of the costs of production.³⁰

Costs

Cost of roughage	\$29.95	
Cost of grain	21.43	
Cost of delivering milk to creamery	6.04	
Overhead charges (labor, interest, depreciation, etc.)	<u>55.00</u>	
Total costs		\$112.42

Credits

Calf	\$ 3.00	
Manure	<u>17.12</u>	
Total credits other than milk		<u>20.12</u>
Net cost of milk		\$92.30

Net cost of milk	\$92.30
Feed cost	<u>51.38</u>
Net fixed charges	40.92
Value of whole milk	100.67
Net cost of milk	<u>92.30</u>
Profit	\$ 8.37

Cost of 100 pounds of 4.04 per cent milk \$1.54

Cost of 1 pound of fat in whole milk .38 1/10

The average price received for 4.04 per cent milk was \$1.68 per cwt. or 41.6 cents per pound for the butter fat, which is 3.5 cents above the net cost of production. These records show that a fair profit can be made from cows with the above production. The costs at present are considerable higher because of the increased cost of feed and labor. However, mainly due to the "Dairymen's League", milk prices have increased relatively more than feed and labor costs.

The author is personally acquainted with conditions in Trumbull County, Ohio. Dairying has been for many years the major farm enterprise. The climatic conditions are such that the cows are on pasture for about five months of the year and receive their roughage

in the stable during the other seven months. Practically all of the farmers feed grain during the winter and most of them supplement pasture with a small amount of grain during the summer. Most of the dairy farmers have silos and a major part of the farm crops are raised primarily for the purpose of supplying feed for the cows. Formerly the milk was sold to local cheese factories but today it is mostly sold to commercial milk companies of Pittsburgh, Pa., Youngstown, Ohio and other cities. Judging from the general prosperity of the farmers in this county one could not conclude that they have been conducting their dairy business at a loss. Their conditions and prices received for their milk are not materially different from those of any other milk producing section of the East. Despite the statements of many authors to the contrary, these farmers have found dairying to be a paying business.

From July 1, 1915 to July 1, 1916 the author was supervisor of the Shenango Valley Cow Testing Association in Mercer, County, Pennsylvania, and Trumbull County, Ohio. The herds comprising this association were slightly above the average production of the cows in that locality but several of the herds were made up almost entirely of heifers so that the costs of production

represent very nearly the average costs in that section. The milk from about one-half of the herds was sold to the Reick Company of Pittsburgh, Pa. The prices paid by this company are practically the same as those paid by the large milk companies of New York City. The average production of the cows in this association was 6,700 pounds of milk and 266 pounds of butter fat or an average test of practically 4 per cent. The following is a statement of the costs of production, and value of product based on the prices paid by the Reick Company from July 1, 1915 to July 1, 1916.

Costs

Cost of roughage	\$28.65
Cost of grain	<u>24.30</u>
Total food cost	\$53.95

The average price paid by the Reick Company for 4 per cent milk was \$1.68 per cwt. or 42 cents per pound for the fat.

Value of product	\$111.72
Food cost	<u>53.95</u>
Returns above food cost	57.95
Net fixed charge based on the problem used in this thesis	<u>42.70</u>
Net profit per cow	\$15.07

Cost of 100 pounds of 4 per cent milk	\$1.45
Cost of 1 pound of fat in whole milk	.36 3/10

These costs are about 6 per cent lower than those for the Cortland Association, which is due to the fact that the average annual production was about 20 pounds more butter fat per cow.

On the basis of the above costs and prices it would be interesting to figure the minimum production necessary to cover all expenses. The feed cost was \$53.95 and the net fixed charges \$42.70, making a total cost of \$96.65. At \$1.68 per cwt. for 4 per cent milk or 42 cents per pound for butter fat it would require a production of 5,750 pounds of 4 per cent milk or 230 pounds of fat to cover the total costs. However, the actual feed costs for a 230 pound cow would be less than for a 266 pound cow, and under conditions typical of western Pennsylvania and eastern Ohio, a production of 225 pounds of butter fat per year represents about the minimum necessary to cover all costs. Of the 29 herds in the Shenango Valley Association but five were below the 230 pound mark and two of these were composed chiefly of two and three year-old heifers.

While employed by the above association the author had occasion to observe conditions in many herds other than those which were tested and he feels safe in stating that a large majority of the dairymen in that

section of the country are producing milk at a reasonable profit. Where they are not it is mainly due to conditions which can be remedied by the dairyman himself.

Since the above data was gathered feed prices, especially for grain, have increased from 30 to 40 per cent, but the price of milk has also advanced so that the relation between costs and prices remains about the same. The price schedule recently announced by the New York Dairymen's League, which applies to a large number of milk producing sections of the East, is as follows. for 3 per cent milk:- April \$2.05 per cwt, May \$2.00, June \$1.90, July \$2.10, August and September \$2.55. These prices are for milk within 100 miles from New York City. When more than 100 miles distant the price is 10 cents less per cwt. An increase of $3\frac{1}{2}$ cents per point is made for milk testing over 3 per cent, making the prices for 4 per cent milk as follows:- April \$2.40, per cwt., May \$2.35, June \$2.25, July \$2.45, August and September \$2.90.

In the April 13, 1917, issue of the "Hoards Dairyman", the Chicago milk prices for the past ten years are given. The prices are per 100 pounds net, at condensory and bottling plants under contract of six months, starting April and October of each year. The following

are the average prices for each year beginning April 1, computed from the monthly prices as given in the table³¹.

1907-08	\$1.37	per	cwt.
1908-09	1.34	"	"
1909-10	1.42 $\frac{1}{2}$	"	"
1910-11	1.57	"	"
1911-12	1.53	"	"
1912-13	1.48	"	"
1913-14	1.70	"	"
1914-15	1.70	"	"
1915-16	1.46 $\frac{1}{2}$	"	"
1916-17	1.77 $\frac{1}{2}$	"	"

Average for the ten years \$1.53 $\frac{1}{2}$ per cwt.

The average spot cash price of corn at Chicago for these ten years was 67 cents per bushel³². There does not seem to be any direct relation from year to year between the price of milk and the price of corn. For instance, the average price of milk per cwt. for 1915-16 is \$1.46 $\frac{1}{2}$ while the price of corn for the same period is 72 cents per bushel. During 1910-11 the average price of corn is but 60 cents while the price of milk is 1.57 per cwt. However, it is interesting to note that on the ten year averages there does seem to be a relation between the price of corn and the price of milk.

Under the conditions of the problem used in the preceeding chapters the feed cost of 100 pounds of 4 per cent milk was found to be \$.892 and the net fixed costs \$.688. The average feed costs per year will vary largely in accordance with the price of corn as the charges for silage and hay were based on the price of corn and the price of mill feeds is controlled largely by corn prices. The net fixed charges will remain nearly the same although at present they are somewhat higher due to the increased cost of cows and labor. On the basis of 70 cent corn the feed cost of 100 pounds of 4 per cent milk was found to be \$.892 or 1.274 of the price per bushel of corn. The feed cost based on 67 cent corn would be 67 cents times 1.274 equals 85.3 cents. 85.3 cents plus 68.3 cents equals \$1.54 net cost per cwt. of 4 per cent milk for the ten year period of 1907-17 inclusive. The average wholesale price of milk at Chicago during this ten year period was \$1.53 $\frac{1}{2}$, showing that, under conditions similar to the ones used in this thesis and with a herd producing 6,250 pounds of 4 per cent milk, the prices received for milk would just about balance the net cost of production. Thus on the basis of these calculation, the

price received by the producer on the Chicago market has been just enough to pay him for the market price of his feed, a fair wage for his labor, and the current rate of interest on the capital invested. Now the question arises, how many of the producers supplying milk for the Chicago market have herds which will average 6,250 pounds of 4 per cent milk per year? Perhaps a majority of them will average lower than this figure but we must also consider that a great many of the dairymen are producing milk under conditions such that many of the items of cost are lower than those on which the above calculations were made.

The Chicago Milk Producers' Association, which furnishes the bulk of the milk to Chicago and nearby cities, has recently announced the following schedule for the next six months. This schedule has been accepted by the dealers. April \$2.40 per cwt., May \$2.00, June \$1.60, July \$2.12, August and September \$2.30. These prices are for 3.5 per cent milk and 3 cents is added for each one-tenth of a per cent above 3.5, while 3 cents is deducted for each one-tenth of a per cent below 3.5 per cent milk.

CONCLUSIONS.

After having studied the costs of production the author does not arrive at the conclusion, as have most writers, that a majority of the dairymen in this country are producing milk at a loss, when all costs are taken into consideration. Some dairymen of course are below the margin of profit but this is true of any line of farming or other business enterprise. The many varied conditions under which milk is produced cause a great variation in costs. Location as to distance from the markets and transportation facilities cause much variation in the price received for milk at the farm. Whether or not it is advisable for the farmer to produce milk as a side issue to other farm enterprises or as a major proposition will depend on his local conditions regarding the costs with each method, the profitableness of other farm operations, and the market facilities for dairy produce.

In order for the individual dairyman to determine what his produce is costing him he must keep an account of the items of cost which enter into his operations. If he is a breeder of purebred cattle, a separate

account should be kept for his breeding operations in order to eliminate any influence they might have on milk costs. In keeping his accounts the dairyman should, as far as possible, consider the production of milk as a business in itself. If, as is often the case, the dairy is a means through which other farm operations are made more profitable, the dairy should be given due credit for the same. The system of accounts outlined in the preceeding chapters can be applied to nearly any type of management and it enables the dairyman to put each item of cost and credit in its proper place.

This study of milk production costs warrants the following conclusions:

1. The variations in the prices of feeds and in the costs of other items, or in other words various conditions under which milk is produced, cause a wide range of costs in milk production.

2. Aside from these variations, the main factor in milk costs is the productive capacity of the cows. A higher average production per cow is absolutely essential for the cheaper production of milk and butter fat.

3. In stating the cost of a quart of milk the per cent of fat should always be taken into consideration as both the food value and the cost of producing a

quart of milk are largely dependent on the fat contained in it.

4. The feed and labor represent the main items of cost and together amount to 70 per cent of the total costs, 46.3 per cent of this being feed costs and 23.7 per cent labor costs. These two items amount to 85.6 per cent of the net costs of which 56.6 per cent is feed costs and 29 per cent labor costs.

5. The extent to which pasture can be used is a very important item in feed costs as pasture represents our cheapest source of food nutrients.

6. Under some conditions summer dairying may be more profitable than producing milk throughout the year.

7. The extent to which it is profitable to purchase grain will depend on the cost of the grain, cost of other feeds, and price received for the dairy produce as well as the productive capacity of the cows.

8. The credit to be allowed for manure will depend on the kind and amount of feed consumed, the type and condition of the soil to which the manure is applied and the value of the crops grown.

9. Unders some conditions the dairyman will find it more profitable to produce milk as a side issue to other farm enterprises while under other conditions specialized dairy farming will be found to be more attractive.

The cost of producing a unit of dairy produce will usually be higher with the specialized dairyman. He cannot compete with the small producer on the basis of the same grade of produce unless that produce be of a high quality.

10. The extra cost of high grade milk is due to the necessity for more expensive equipment and the greater amount of labor required.

11. With the present prices of feed and labor a herd of cows producing 6,250 pounds of 4 per cent milk or 250 pounds of butter fat will when properly managed pay all charges including 6 per cent interest on the capital invested, and in addition return a small profit to the dairyman for his services as manager.

12. Where the cows utilize feed and labor that could not otherwise be used to advantage and other items of cost are relatively inexpensive, cows with a lower production will return their owner a profit.

13. It does not pay to use intensive methods with low producing cows.

14. The keeping of cost accounts is essential to better dairy conditions. It not only benefits the individual dairyman who keeps the accounts but also has an indirect benefit to the public in general by making it possible to put the dairy business on a sound basis throughout the country.

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40. Same as 7, page 4.
41. Same as 6, page 216.
42. Same as 1, page 9.
43. Same as 5, page 140.
44. Same as 15, page 72.
45. Same as 6, page 126 (Computed from data in Table 5.)
46. Same as 7, page 19.
47. Same as 9, page 20.
48. Same as 5, page 153.
49. Same as 6, page 147.
50. Same as 7, page 9.
51. Same as 3, page 130.
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52. Same as 9, page 23.
 53. Same as 9, page 28.
 54. Same as 7, page 12.
 55. Same as 6, page 130-131.
 56. Same as 9, page 36.
 57. Same as 9, page 26.
 58. Same as 7, page 10.
 59. Same as 2, page 5.
 60. Same as 3, page 130.
 61. Same as 6, page 173.
 62. Same as 9, page 39.
 63. Same as 7, page 14.
 64. Same as 2, page 6.
 65. Same as 2, page 6.
 66. Same as 3, page 130.
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 70. Same as 6, page 133.
 71. Same as 7, page 15.
 72. Same as 9, page 45.
 73. Same as 7, page 14.
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 75. Same as 15, page 64 (Table 8.)
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