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JUDGING CREAMERY EFFICIENCY

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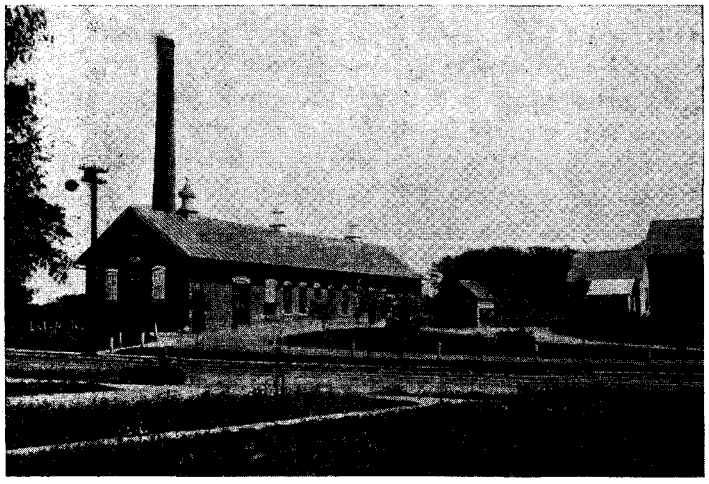

UNIVERSITY FARM, ST. PAUL

SUMMARY

The best test of creamery efficiency is the price paid to patrons for butterfat. This price, however, is determined by the price received for butter, overrun, and creamery margin, each of which is further dependent on a large number of other factors, some of which can be controlled by the creamery in a relatively short time while others can not.

Butter prices, overruns, and creamery margins vary widely from creamery to creamery, but these factors are not of equal importance in causing variations in price paid for butterfat. Prices received for butter and creamery margins are closely related to the type of dairying practiced in the community.

The chief causes for variations in overrun reported by creameries are variations in the fat content of butter, in losses of butterfat in the creamery, and in the practice of weighing cream and reading cream tests. Higher prices can be paid for butterfat by keeping the fat losses in the creamery and the fat content of butter at a minimum. The law requires, however, that butter contain at least 80 per cent butterfat. Creameries can control the fat content of butter between 80 and 81 per cent. If the fat content of butter is controlled at 80.5 per cent and butterfat losses in the plant at 1.4 per cent of the butterfat received, the overrun should be approximately 22.5 per cent.

The margins taken by creameries are primarily costs, but frequently they include an element of surplus. Creamery costs are divided into four groups: Building and site, labor and management, equipment, and supplies and miscellaneous. The costs for each of these groups as well as the total costs per 1000 pounds of butter vary widely from creamery to creamery. Variation in volume of business is one of the principal causes for variation in costs, but adjustments of the building, equipment, and labor force to a given volume are also important. This bulletin sets up a standard by which a creamery can compare its costs with the average of other creameries handling the same volume of business and discover wherein its costs are out of line. Costs, however, must always be considered in relation to the quality of the service rendered. In order to compare the costs of an individual creamery with those of the average creamery, they must be calculated by the same method. The methods for making such calculations are explained and illustrated.

JUDGING CREAMERY EFFICIENCY

By B. A. HOLT and W. B. COMBS

Creamery patrons, members of boards of directors, and operators and managers should aim to make their creameries as efficient as possible. The purpose of this bulletin is to present an analysis of some of the factors of efficiency and also a method by which the efficiency of a creamery can be judged. The data presented are the same as those in Minnesota Technical Bulletin No. 26, entitled "Economic Aspects of Creamery Organization,"[1] except that they have been revised to fit 1925 conditions.

Undoubtedly many tests might be set up as a basis for determining the relative efficiency of creameries, but the price paid to patrons for butterfat seems to be the best single test. Operators and managers are likely to stress the overrun or the score of butter as indications of efficiency. These, however, are important only so far as they make it possible to pay higher prices for the butterfat received.

Some of the differences in price paid for butterfat, however, are due to such things as difference in quality of cream received, rather than to differences in efficiency. Others are due to differences in plant or in volume of business, that can not quickly be remedied.

For creameries which sell all their butterfat in the form of butter, the price paid for butterfat is determined by three things: the price received for the butter, the overrun (the percentage increase in pounds of butter sold over pounds of fat purchased), and the creamery margin, i.e., the difference between the price received by the creamery per pound of butterfat and that paid to patrons.

The price received per pound of butter is in turn influenced by:

1. Quality of cream received—
    a. Density of butterfat production in community.
    b. Care of cream on the farm.
    c. Method and frequency of delivery.
    d. Grading, and method of paying for quality.
2. Quality of butter made from a given grade of cream—determined largely by the skill of the buttermaker and the equipment with which he has to work.
3. Marketing considerations—
    a. Local sales—kind of product sold, amount, and price basis.
    b. Distance to market—transportation costs.
    c. Selling methods.
    d. Shipping method—carlot vs. less than carlot.
    e. Seasonality of production.

[1] By John D. Black and Edward S. Guthrie. (The bulletin is now out of print.)

Overrun is in turn influenced by—

a. Butterfat losses in plant—in buttermilk, pipes, vats, etc.
b. Composition of butter.
c. Accuracy of testing and weighing cream.
d. Method of calculating pounds of butter.

The margin per pound of fat taken by the creamery is influenced by—

1. Costs of operation, determined by utilization of and prices paid for—
   a. Labor and management.
   b. Building and site.
   c. Machinery and equipment.
   d. Supplies and miscellaneous.
2. Such other deductions as surplus or reserves for expansion, new equipment, debt retirement; also profits, in the case of proprietary creameries.

The price paid to patrons per pound of butterfat equals the price received for the amount of butter made from it, less the operating margin on that amount of butter. The higher the true overrun the more butter sold per pound of butterfat and, other things being the same, the higher the price paid for butterfat. Also the higher the price received for butter or the lower the operating margin, overrun being the same, the higher the price paid for butterfat.

Of the foregoing factors, some can be controlled in a relatively short period of time; some only over a longer period. They are classified below on this basis:

Changeable Rather Quickly

A. Care of cream on the farm.
B. Method and frequency of assembling the product.
C. Grading methods and payments for quality.
D. Quality of butter made from a given grade of cream.
E. Price basis for local sales—particularly to patrons.
F. Butterfat losses in the plant.
G. Composition of the butter.
H. Accuracy of testing and weighing.
I. Labor and management costs.
J. Supplies and miscellaneous costs.
K. Shipping by carlots instead of less than carlot.

Changeable Slowly (if at all)

A. Density of butterfat production in the community.
B. Distance to market.
C. Seasonality of production.
D. Building and site costs.
E. Machinery and equipment costs.
F. Volume of business.

Figure 1 shows how prices paid for butterfat, prices received for butterfat and butter, overruns, and margins taken for running the creamery varied in 600 Minnesota co-operative creameries in 1924. If each creamery had received 40 cents per pound for its butter, obtained an overrun of 23.5 per cent, and taken a margin of 4.6 cents, which are the averages for the 600 creameries, each would then have paid 44.8 cents per pound for fat. But, as illustrated, the prices received for butter ranged from 35 to 45 cents, overruns from 18 to 31 per cent, and margins from 0.5 to 9.5 cents,[2] with a consequent range in prices paid for butterfat from 36 to 52 cents per pound. These variations are all large.

Closer analysis, as in Table I, shows that the price received for butter is the most important factor, and creamery margins are second in importance. In Group I, two creameries are assumed with a difference of 8 cents in price received for butter (just a little less than the extreme range), but with average creamery margin and overrun. Under the circumstances the price paid for butterfat would vary 10 cents per pound, from 39.8 to 49.7, inclusive. In Group II, a range in operating margin of 6 cents, with average price received for butter and average overrun, makes a difference of but 6 cents in the price paid for butterfat.

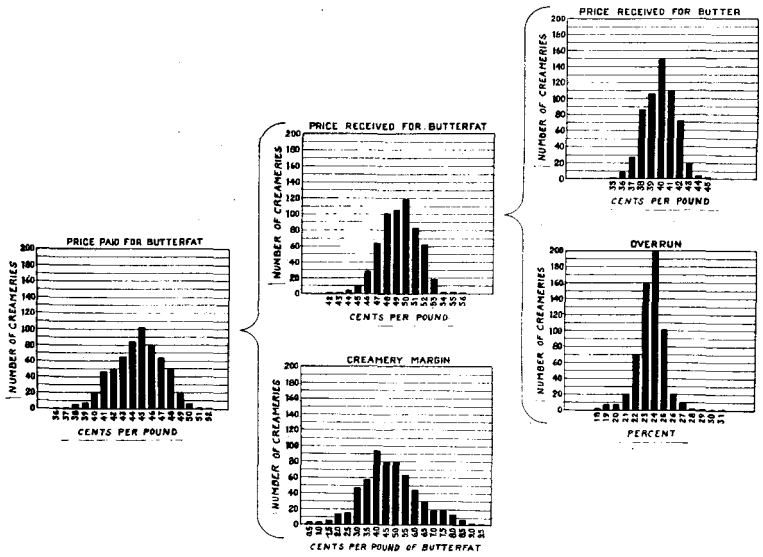

Fig. 1. Variations in Prices Paid for Butterfat, Received for Butter and Butterfat, Creamery Margins, and Overruns for 600 Minnesota Creameries for 1924

The information on which the chart is based was obtained from the reports made by co-operative creameries to the State Dairy and Food Commission.

[2] Some of the expense margin must be due to error in the records.

In Group III, a range of 8 per cent in overrun, with average price received for butter and average creamery margins, makes a difference of only a little over 3 cents in the price per pound for butterfat.

TABLE I

RELATIVE IMPORTANCE OF VARIATIONS IN BUTTER PRICE, OVERRUNS, AND CREAMERY MARGINS IN CAUSING VARIATIONS IN PRICES PAID FOR BUTTERFAT

Creamery and group	Price received for butter	Creamery margin	Overrun	Price paid for butterfat
	Cents	Cents	Per cent	Cents
Group I				
A	44	4.6	23.5	49.7
B	36	4.6	23.5	39.8
Group II				
C	40	2.0	23.5	47.4
D	40	8.0	23.5	41.4
Group III				
E	40	4.6	27.0	46.2
F	40	4.6	19.0	43.0

Figure 2 presents the same results graphically. Line A shows the effect on the price paid for butterfat of varying the price of butter above and below 50 cents, assuming an average overrun of 23.5 per cent, and a creamery margin of 4.5 cents. A price of 50 cents for butter was taken as a middle point because it is about normal at the present time. Line B shows the comparable effect on butterfat price of varying creamery margins above and below 4.5 cents; and line C, the comparable effect of varying the overrun above and below 23.5 per cent. The effect of any change in any of these three factors on the price paid for butterfat may be read from the chart, taking as a basis the 600 cooperative creameries in Minnesota in 1924. The relative importance of the three factors is at once apparent. Line D shows the combined effect of variations from the middle of all these factors at once.

A considerable part of the variation in prices received for butter and consequently in prices paid for butterfat, as previously noted, is due to differences in quality of the raw material obtainable. In Figure 3 the state is divided into eight sections, based on the relative importance of the dairy industry. Table II shows for each section the average price received by the creameries for butter, the average price paid to patrons for butterfat, the average overrun, and the average margins taken by the creamery. In sections of the state where dairying is intensive, more attention is given to the factors which affect the quality of cream than in other sections. Better care is taken of the cream on the farm, deliveries to the creamery are made more frequently, and the creameries, on the whole, are in a position to grade the cream received and consequently pay prices which reflect quality differences. In judging the success of a particular creamery, it is better to make a comparison with the average for the creameries in the same

dairy section rather than for all creameries in the state. Some creameries in Section 4, for example, have better conditions and should pay better prices than some, not so well situated, in Section 2 or Section 3. Not too much must be made of these district averages.

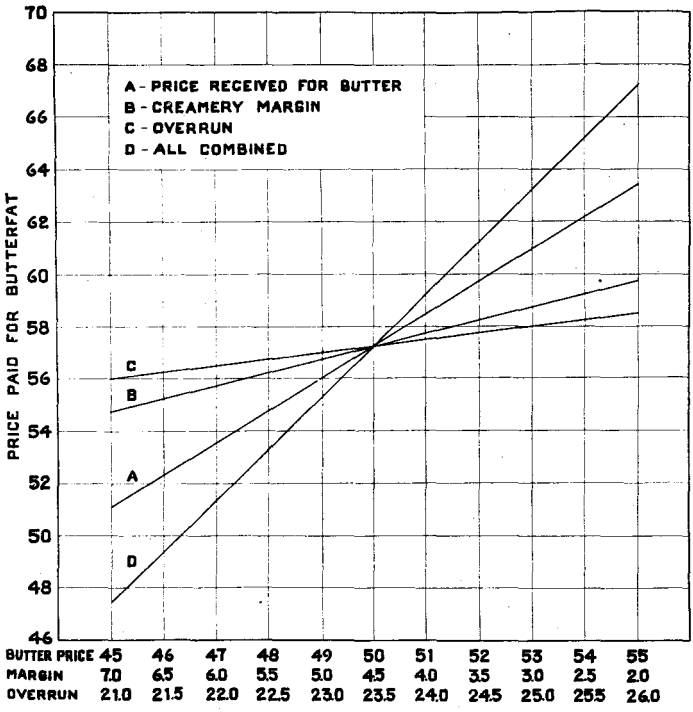

Fig. 2. Relation of Butter Output to Creamery Costs

OVERRUN AS AN EFFICIENCY FACTOR

Variations in overrun are due to (1) Variations in the composition of butter manufactured, (2) inaccurate weighing and testing of cream at the receiving platform, (3) loss of fat in buttermilk from mechanical sources, (4) inaccurate weighing of butter manufactured, (5) type of butter manufactured (salted or unsalted), (6) milk or cream sold as such, on which overruns are calculated. Assuming that a creamery makes a legal grade of butter so far as composition is concerned and that the butterfat content in excess of this legal limit does not increase the price received for it, then Factors 1 and 2 are efficiency factors, which means that proper control over them will enable a creamery to pay a higher price for the actual pounds of butterfat delivered. Underweighing and undertesting, while increasing the overrun reported by

the creamery and increasing the price paid per pound of butterfat, do not result in gain to the farmer, for he is paid for a smaller number of pounds of fat than he actually delivers.

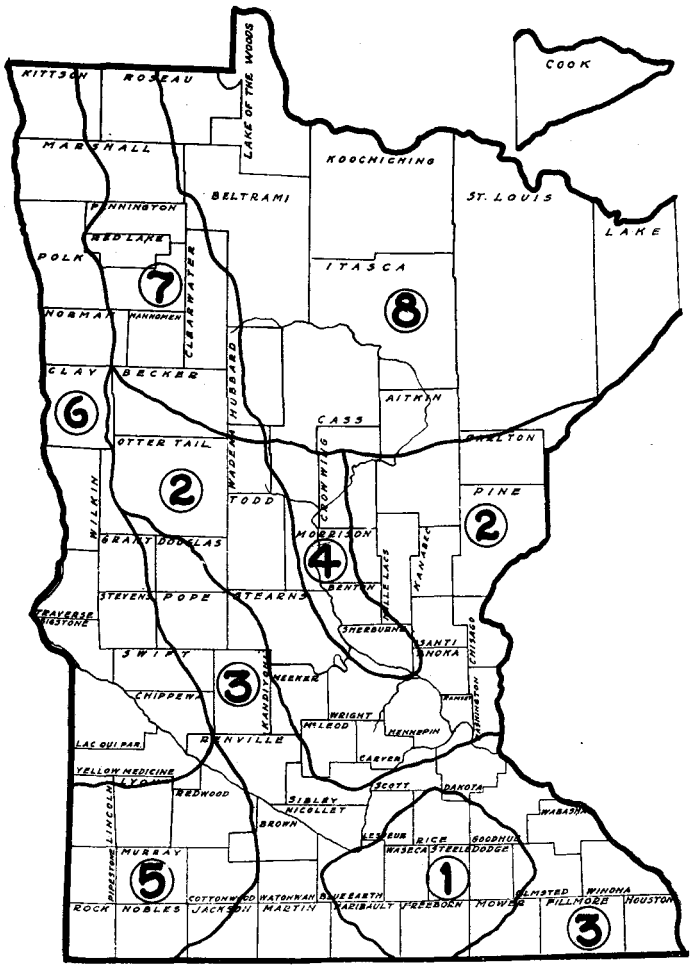

Fig. 3. The Eight Dairy Sections in Minnesota (See Table II.)

The true maximum overrun of a creamery is limited, as the law requires that butter contain at least 80 per cent butterfat. Assuming correct testing and weighing, and overlooking the mechanical losses of butterfat in the creamery, the highest possible legal overrun is 25 per cent. The creameries shown in Figure 1 as having overruns above 25 per cent must either have made errors in their reports to the State Dairy and Food Commission or made illegal butter or underweighed or undertested. The abnormally low overruns are probably due to

errors in reporting, to mechanical butterfat losses, or to putting more butterfat into the butter than the law requires. Errors in the reports probably account for most of the creameries reporting overruns over 27 per cent and under 20 per cent.

TABLE II

AVERAGE PRICES PAID FOR BUTTERFAT AND RECEIVED FOR BUTTER, CREAMERY MARGINS, AND OVERRUNS IN EIGHT DAIRY SECTIONS IN MINNESOTA, 1924

Section	Number of creameries	Price paid for butterfat	Price received for butter	Overrun	Creamery margin
		Cents	Cents	Per cent	Cents
1. Southern Dairy	103	46.4	40.9	23.2	4.0
2. Central Dairy	191	44.7	40.1	23.5	4.8
3. Intermediate Dairy	165	43.9	40.4	23.6	6.0
4. Mississippi Valley	26	42.4	39.0	23.0	5.6
5. Southwestern Corn	26	42.4	39.0	23.6	5.8
6. Red River Valley	38	41.2	38.1	23.0	5.7
7. Northwestern Dairy	37	41.8	38.3	23.5	5.5
8. Cut-over	14	41.9	40.1	22.8	7.3
All sections	600	44.8	40.0	23.5	4.6

Failure to control the butterfat content of butter at approximately the legal minimum is undoubtedly an important cause of low overruns. An analysis of 1000 samples of salted butter shipped by various members of the Land O' Lakes Creameries, Inc, from January to April, 1925, showed a range in fat content up to 85 per cent, with an average of 81.31 per cent. This is a considerable improvement over the results of tests of market butter made in previous years. Butterfat composition can, however, be controlled within very narrow limits, as many individual creameries have demonstrated. It has been suggested by the dairy division of the University of Minnesota that the operator choose a standard of 80.5 per cent as an ideal toward which to work. The butterfat content of butter can be controlled within a range of a fraction above 80 per cent to 81 per cent. In no case should butter be removed from the churn which is not a fraction above 80 per cent. A standard of 80.5 per cent would give a true overrun of approximately 24.2 per cent. The mechanical losses of butterfat probably range from under 1.0 per cent of the amount delivered, for large creameries, to over 2.0 per cent for small creameries. The average loss is about 1.4 per cent. If we assume that mechanical losses can be kept at 1.4 per cent and that a standard of 80.5 per cent butterfat is followed, a standard overrun of 22.5 per cent can be set up.

The assumption thus far has been that overruns are calculated on the basis of the actual pounds of butter made. But perhaps the more common practice is to estimate the amount made from the number of tubs and other units of butter packed. Many creameries aim to pack 63.5 pounds of butter in the ordinary 63-pound tub.

Where this practice is followed, the estimated weights are about 0.8 per cent smaller than actual weights. The standard overrun, if the weight of butter is calculated in this manner, would be approximately 21.5 per cent.

Tables III and IV show the effects on overrun of under-reading the butterfat test and of underweighing cream. In each table, comparisons are made with actual overruns of 22.5 and 21.5 per cent. For actual overruns of 22.5 or 21.5 per cent, and actual butterfat tests of 30 per cent, each reading of 0.5 per cent below the actual test increases the overrun approximately 2 per cent. Where the actual overrun is 22.5 per cent, a reading of 29.5 instead of 30 per cent results in an overrun of 24.6 per cent. The effect on overrun of underweighing cream depends upon the butterfat test of the cream and the average size of the unit of delivery. Overruns are increased twice as much when the average unit of delivery is 5 gallons as when it is 10 gallons, providing the underweighing is the same in each case. Table IV shows that for cream testing 30 per cent butterfat, each quarter pound of underweight increases the overrun on 5 gallons by 0.8 per cent, on 8 gallons by 0.5 per cent, and on 10 gallons by 0.4 per cent.

TABLE III

EFFECT ON OVERRUN OF UNDER-READING BUTTERFAT TEST OF 30 PER CENT CREAM*

Butterfat reading	Overruns	
	Per cent	Per cent
Correct readings	22.5	21.5
0.5 per cent below	24.6	23.6
1.0 " " "	26.7	25.7
1.5 " " "	28.9	27.9
2.0 " " "	31.3	30.2

* The method of calculation is as follows: 100 pounds of cream testing 30 per cent will make 36.75 pounds of butter at 22.5 overrun. (36.75÷30 is 1.225) If the test is read 29.5, the overrun will read 24.6 (36.75÷29.5 is 1.2457).

TABLE IV

EFFECT ON OVERRUN OF UNDERWEIGHING CREAM*

Weighing method	5-gallon units†		8-gallon units		10-gallon units	
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Correct weight	22.5	21.5	22.5	21.5	22.5	21.5
0.25 pounds below	23.3	22.3	22.8	21.8	22.9	21.9
0.50 " "	24.0	23.0	23.4	22.4	23.3	22.3
0.75 " "	24.8	23.8	23.8	22.8	23.7	22.7
1.00 " "	25.6	24.6	24.4	23.4	24.0	23.0

* Assumptions: actual overruns, 22.5 and 21.5 per cent; cream test, 30 per cent.

† Five gallons is 40 pounds, which at 30 per cent test is 12 pounds of butterfat, which at 22.5 per cent overrun is 14.7 pounds of butter. But 39.5 pounds at 30 per cent test is 11.85 pounds of butterfat. 14.7÷11.85=1.24.

A co-operative creamery may pay the same total amount for butterfat during a given period regardless of its weighing and testing practice, but underweighing and undertesting may result in an unfair distribution

of this amount between patrons. Underweighing tends to penalize the patrons whose tests are high or whose delivery units are small. The effect of undertesting, on the other hand, is to penalize the patrons with low tests and bears no relation to the size of the delivery unit. Thus the final outcome in a particular creamery depends (1) on the extent of the practice; and (2) on the variations among patrons in the size of delivery units and in the butterfat test of cream.

COSTS AS EFFICIENCY FACTORS

The largest single factor affecting creamery costs per pound of butter is volume of business, or output. To judge its own costs properly, therefore, a creamery must compare them with those of other creameries handling the same output. Table V shows how the costs of 88 Minnesota creameries varied with output in 1925.

TABLE V

RELATION OF BUTTER OUTPUT TO CREAMERY COSTS

Output (thousands of pounds)	Costs per thousand pounds of butter				
	Equipment	Building and site	Labor and management	Supplies and miscellaneous	Total
100	$5.00	$6.75	$20.20	$16.50	$48.45
200	4.25	3.75	15.75	14.25	38.00
300	3.75	3.00	13.67	13.15	33.57
400	3.25	2.55	12.75	12.25	30.80
500	3.00	2.45	12.30	11.50	29.25
600	2.75	2.40	11.50	10.65	27.30

Some people understand this relationship more readily when expressed as curve E in Figure 4. A further advantage of a curve is that it can be read for outputs between those named in the table.

The method of reading costs for a particular output from Figure 4 is as follows:

Assume a creamery making 200,000 pounds of butter. Read up to 200 in the vertical scale at the left. Follow the horizontal line at this point across the chart till it crosses curve E. Drop a vertical line from this point to the base line, and read the cost in dollars per 1000 pounds on the base line. For any output in figures between the hundred thousands, it will be well to draw in a new horizontal line.

Read off in this way, $38 per 1000 pounds of butter is the average cost for creameries of 200,000 pounds output in Minnesota in 1925,[3] or as near to the figure as it is possible to get on the basis of 88 creameries. The average cost for 300,000-pound creameries on this basis would be about $34 per 1000; for 400,000-pound creameries, about $31; for 250,000-pound creameries, about $36.

[3] This is the curve given in Minnesota Technical Bulletin No. 26, adjusted for changes in prices since 1920.

The next step for any creamery is to calculate its own costs per 1000 pounds of butter. This it can do roughly by adding to the expenditures for the year an allowance for depreciation and interest on plant and equipment, and dividing by the annual output. (How to do this more accurately will be explained later.) If any creamery finds that the cost is more than the average for the output, it should by all

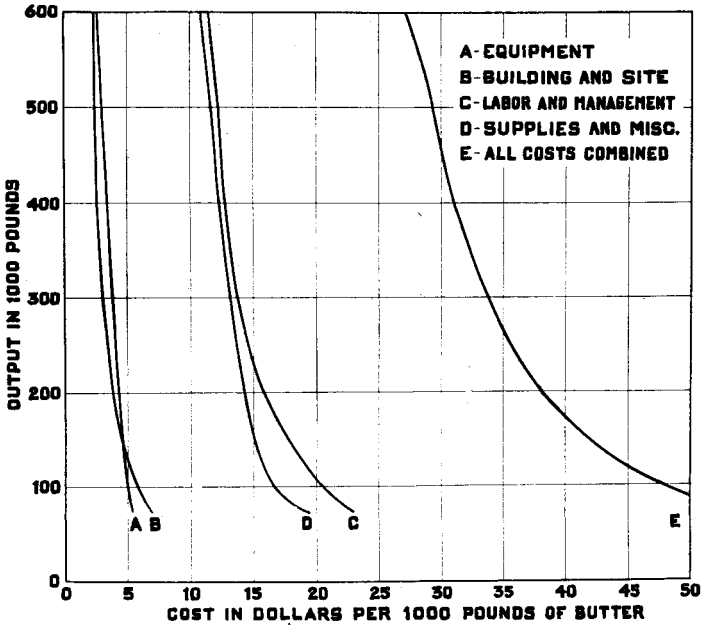

Fig. 4. Effect of Changes in Butter Prices, Creamery Margin, and Overruns on Price Paid for Butterfat

means analyze further and find out why. Even if its costs are less than the average, it will pay to analyze further, for it must be remembered that half the costs are always less than the average—the average is always in the middle—and no creamery should be fully content as long as any other has a lower cost, unless it can justify its higher cost by a better quality of product or in some other sufficient way.

To analyze further, the first step is to break up the total creamery cost per 1000 pounds of butter into separate parts. In Figure 4 total costs are divided into four groups: equipment, building and site, labor and managment, and supplies and miscellaneous; and average curves for any output for any one of these four costs. A creamery should next calculate its own costs under these four heads. If any creamery finds that any one of these four costs is high, it should at once proceed

to find out why. Some creameries will be high in some costs and low in others; some prevailingly high or low in all four costs.

Costs and Quality of Service

Before an analysis can be made understandingly, however, the following explanations must be made: An analysis of costs is incomplete unless the quality of product and amount and quality of other services received for these costs are known. The quality of service rendered by a creamery is measured largely by the price paid for butterfat. If high costs result in higher prices for butterfat, surely they are desirable. Likewise, what might appear on the face as high labor and management cost may be offset by the fact that the operator and manager is performing valuable service in the community in addition to making butter. It may be that his apparently high salary is repaid several times by his success in improving the quality of cream delivered, or his advice in the care and feeding of dairy cows for more efficient production. The quality of service a patron gets at the creamery is often an important factor in continuing his patronage. It is impossible to measure quality of service in dollars and cents as we can costs, but it must not be overlooked.

Relation of Volume of Output to Costs for Any One Creamery

The other thing that must be explained is that the curves in Figure 4 can not be used to determine how much an individual creamery can reduce its costs by increasing its volume of business; for unless a creamery is already using its labor force and its building and equipment to full capacity, it should be able to reduce its cost with additional output somewhat more than these curves indicate. This is because a creamery with a given plant, equipment, and labor force can usually handle a somewhat larger output without increasing the total costs for the four groups, but after a certain size is reached, a new helper must be added, more equipment purchased, or the building enlarged. These additions need not all come at the same time, and they will vary with the size of the plant, the labor force, and the amount of equipment at the beginning. Before these additions are needed, however, increased volume results in a very rapid decrease in costs. After the additions are made, cost increases and further cost reductions are dependent on further increase in volume. Table VI shows the average total labor and management costs per creamery and per 1000 pounds of butter for the 88 creameries illustrated in curve C of Figure 4, with similar costs for an individual creamery whose volume of output has increased from 75,000 to 600,000 pounds of butter. Figure 5 shows the same information graphically. The abrupt jumps in the cost

curves for the individual creamery, as noted in the table, are due to increases in the labor and management payroll.

TABLE VI

RELATION OF BUTTER OUTPUT TO LABOR AND MANAGEMENT COST PER CREAMERY AND PER 1000 POUNDS OF BUTTER FOR THE AVERAGE CREAMERY AND FOR AN INDIVIDUAL CREAMERY

Output (thousands of pounds)	Average creamery		Individual creamery	
	Total cost	Cost per 1000 pounds	Total cost	Cost per 1000 pounds
600	$6900	$11.50	$6500	$10.83
550	5617	11.85	6500	11.82
500	6150	12.30	6500	13.00
450	5625	12.50	5000	11.11
400	5100	12.75	5000	12.50
350	4602	13.15	5000	14.29
300	4100	13.67	3500	11.67
250	3500	14.00	3500	14.00
200	3150	15.75	3500	17.50
150	2662	17.75	2000	13.33
100	2020	20.20	2000	20.00
75	1736	23.15	2000	26.67

A creamery, however, does not ordinarily decrease its costs by first increasing its volume of business; instead, it reduces its costs by becoming more efficeint with its given volume. This enables it to pay higher prices for butterfat, and volume increases as the result of the increase in price.

The creamery illustrated in Figure 5, while the illustration is an arbitrary one, shows the misfits which are likely to exist between labor and management costs and output at any given time. Similar misfits exist between output and each of the other cost groups, particularly the building and equipment group. In the supplies and miscellaneous group, the decrease in cost per 1000 pounds of butter as output increases is due primarily to economy in buying supplies, and to the more economical use of fuel in the larger plants.

If the building and site costs of a creamery are found to be higher than those of curve B in Figure 4 for the same volume of business, it indicates that the plant has been overbuilt in the light of present volume. The management may have overestimated the value of locating the creamery on an expensive site, or the plant may be too large or too expensively constructed for the present output. If the plant is new and has been built to meet the needs of an anticipated increased volume which is reasonably certain of being realized in the near future, criticism on the score of poor organization is not in point; otherwise, however, such overbuilding indicates a poor economic organization. Once the plant is constructed, nothing can be done to relieve the difficulty; the building can only serve as a lesson to future creamery

builders. Readjustments are less difficult with equipment, as much of it wears out in a few years. Misfits can then be corrected by buying new equipment in an amount and type to correspond with the output.

High labor and management costs may indicate that volume of business is too small for the present labor force, and yet too large to handle with one less helper. Occasionally the taking on of sidelines or the employing of part-time labor will relieve this difficulty. In some instances, the number of employees is actually too large for the work to be done.

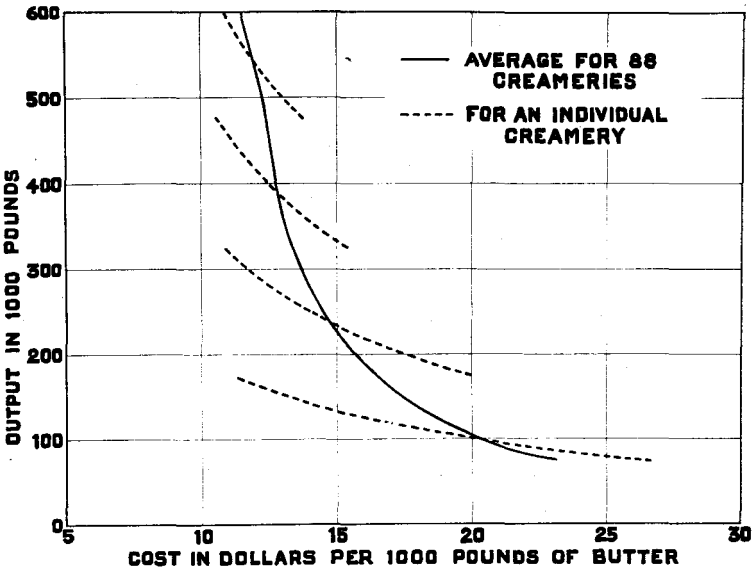

Fig. 5. Relation of Butter Output to Labor and Management Costs per 1000 Pounds of Butter for the Average Creamery and for an Individual Creamery (See Table V.)

Two Dimensions of Cost

The third thing to be explained is that costs may be high either because too high prices are paid for things, or because too much of them is used per unit of output. To illustrate, a creamery with high costs may either be employing more labor and management than it really needs, or may be paying exceptionally high wages and salaries. Both these things may be justified by higher quality of product, but one must be sure that they really are. Similarly, building costs may be higher either because the building is too large or because it is of too expensive construction. In a matter of this kind, a long-time point of view must be taken.

It may be said that the cost of producing a pound of butter has two dimensions: (1) the amount of labor, management, building, and the like used in producing each pound; and (2) the price paid per unit of these things. Multiplied together, they give the cost per pound of butter.

Calculation of Costs for 1925

We are now ready to consider calculating the four groups of costs for any one creamery. The method is simply to separate out the elements making up any one group of costs, add them, and divide by the annual output. This must be done on the basis of 1925 prices, because the curves in Figure 4 are on that basis.

Building and site costs.—The elements of building and site and equipment costs are: taxes, maintenance, insurance, interest, and depreciation. In calculating the annual building and site costs, taxes, maintenance, and insurance can be taken as the amount paid during the year for these items. If taxes and insurance are paid in a lump sum on building and equipment, they must be divided between the two in proportion to their value. In considering maintenance, purchases of additional equipment or definite expansions and improvements in the building must not be included, as these are not expense charges. The calculation of interest and depreciation is more difficult. The first step is to calculate the replacement value (new) of the present building, as if built in 1925. This can be done either by obtaining a construction estimate from some one familiar with the building of creameries or by correcting the original cost of the creamery according to changes in price of building materials and wages which have taken place between the date of construction and 1925. Table VII shows, by 5-year periods, the changes in building construction costs from 1900 to 1925, expressed as index numbers, that is, percentage of 1925 prices. These indexes are based on approximations of costs of materials and labor.

TABLE VII

INDEXES OF COSTS OF CONSTRUCTING CREAMERY BUILDINGS OF VARIOUS TYPES—1900 TO 1925

Year	All brick	All frame	Brick and frame
1900	67	58	64
1905	51	63	55
1910	53	74	60
1915	73	54	67
1920	133	158	141
1925	100	100	100

The interest element in the building and site cost in curve B, Figure 4, includes interest on the site as well as on the building. An interest rate of 7 per cent is used for both building and equipment, and of 4 per cent for site. The amount of interest is determined by applying these rates to the 1925 values. Interest on the building is

calculated by applying the 7 per cent rate to one-half of the 1925 replacement value. By taking replacement cost as a base instead of construction cost, or construction cost depreciated to date, variations in cost arising from the date of construction are avoided. The reason for applying the interest rate to one-half the replacement value is that this represents fairly accurately the average amount of capital tied up in the building throughout its life. The whole construction cost is tied up in a new building; a worn-out building has no investment left in it. The average investment for the whole period is half way between these two extremes. The interest actually paid on fixed indebtedness connected with the building should not be used, as this would result in cost variations to the extent that borrowed capital was used as a method of finance.

The annual depreciation charge is calculated by dividing the replacement value as of 1925 by the estimated life of the building. While construction costs vary with the type of structure, estimated life also varies in the same direction, so that annual depreciation does not depend entirely on the kind of building material used. In Figure 4 the estimated life for brick buildings was 50 years; for frame buildings, 25 years; and for brick and frame combined, 35 years.

Equipment costs.—The elements of equipment cost, as noted above, are the same as those for building, and the methods of calculating them are identical. While rates of depreciation vary somewhat with different kinds of equipment, a rate based on an average life of 15 years has been found to be reasonably accurate. A price list of creamery equipment can be used to reduce the equipment values to the 1925 base.

Labor and management costs.—The annual labor and management cost is the easiest element to calculate. For 1925, this can be taken as the sum of the wages or salaries paid to the buttermakers, helpers, secretaries, managers, directors, and officers. For years after 1925, these payroll items must be corrected by any changes in the general rates of pay. If the labor force is increased to make it possible to conduct a side-line business, such as handling eggs or feed, the additional labor bill must be subtracted from the wage bill. If the same labor force handles it at no additional pay, little or no subtraction need be made.

Supplies and miscellaneous costs.—Supplies and miscellaneous costs include tubs and boxes, fuel and electric power, drayage, liners and circles, salt, stationery, color, paraffin, washing powder, acid, oil, light, ice, water, ammonia, starter culture, wrappers, repairs, glassware, brushes, thermometers, cotton waste, boiler compound, telephone, printing, advertising, and any other miscellaneous item connected with the manufacturing and selling of butter. These should be taken at the

price paid for them in 1925. If more of any of these are on hand at the end of the year than at the beginning, the cost of this amount should be subtracted; if less are on hand, the cost should be added. The cost charged should be for only the amount used during the year. This is very important in the case of fuel, tubs, and a few large items.

Illustrations of the Cost Calculations

Let us assume that the following facts concerning the Riverside Co-operative Creamery are available on December 31, 1925. The plant consists of a brick building constructed in 1910 at a cost of $5500 and equipment of an average age of five years costing $6500, but which could be replaced at present prices for $5500. The site was purchased in 1909 at a cost of $900, but has a present appraised value of $1500. The volume of business for 1925 was 230,000 pounds of butter. An analysis of the expense statement for the year shows total salaries $2990; the value of the items included under supplies and miscellaneous, $3220; maintenance or repairs and upkeep on buildings, $138.33, and on equipment, $179.80; insurance on building and equipment, $50; and taxes on land, building, and equipment, $167.

The calculations of costs for this creamery for 1925 are made as follows:

A. Calculation of replacement value and depreciation on the building:
   - Cost of building in 1910 ..... $5,500.00
   - Replacement value in 1925 ..... 10,377.00*
   - Annual depreciation, based on an estimated life of 50 years 207.50
   - Present value (1925 cost depreciated 15 years to date) 7,264.00†

B. Calculation of the present value and depreciation on equipment:
   - Replacement value of equipment $5,500.00
   - (Depreciation based on an estimated life of 15 years=$5500÷15, or $366.67 for the year. The average age of the equipment is 5 years; hence its present value (1925 replacement depreciated to date)=$5500−(5×$366.67), or $3667.00.)

C. Division of taxes between building, equipment, and site:
   - Tax expense for the year=$167. This, if divided on the basis of present values ($7264, $3666, and $1500), results in a tax on building of $97.60; on equipment of $49.26; and on site of $20.14.

* The index for 1910 in Table VII is 53. This means that a building of this type cost 53 per cent as much to build in 1910 as in 1925. To raise this 1910 cost of $5500 to a 1925 basis, divide $5500 by 53 and multiply the result by 100.

† $207.50×15=$3113.00. $10,377.00−$3113.00 is $7264.00.

D. Division of insurance between building and equipment:

Insurance expense for the year=$50. If divided between building and equipment on the basis of present values ($7264 and $3667) the insurance cost on the building is $33.23 and on equipment $16.77.

E. Calculation of interest costs:

Interest, as previously mentioned, is calculated at 7 per cent on one-half of the 1925 replacement value for buildings and equipment, and at 4 per cent on the 1925 appraisal value of the site. This gives $363.20 (7% of half of $10,377) on buildings; $192.50 (7% of half of $5500) on equipment; and $60 (4% of $1500) on site.

Costs for each of the four groups are now summarized and divided by the output of butter (230,000 pounds).

Summary of Building and Site Costs

Taxes on building, $97.60; on site, $20.14	$117.74	
Maintenance on building	138.33	
Insurance on building	33.23	
Interest on building, $363.20; on site, $60	423.20	
Depreciation on building	207.50	
Total building and site cost		$920.00

Building and site cost per 1000 lbs. of butter=920÷230, or $4.00.

Summary of Equipment Costs

Taxes	$49.26	
Maintenance	179.80	
Insurance	16.77	
Interest	192.50	
Depreciation	366.67	
Total equipment cost		$805.00

Equipment cost per 1000 lbs. of butter=$805÷230, or $3.50.

Summary of Labor and Management Costs

Wages and salaries for year	$2990.00

Labor and management cost per 1000 lbs. butter=$2990÷230, or $13.00.

Summary of Supplies and Miscellaneous Costs

Value of items of supplies and miscellaneous used	$3220.00

Supplies and miscellaneous cost per 1000 lbs. of butter=$3220÷230, or $14.00.

Total of all costs	$7935.00

Total cost per 1000 lbs. of butter=$7935÷230, or $34.50.

Cost Calculations and Comparisons for Years After 1925

The costs in the above illustration are comparable with the curves in Figure 4, as both are calculated by the same method and are for 1925. Creamery costs in the future, however, are likely to be either higher or lower than those shown in Figure 4. In order that a creamery may accurately compare its costs for future years with the average costs of other creameries handling the same volume of business, it will need to adjust its costs to the 1925 base or new cost curves will have to be constructed. The former method will probably give satisfactory results, at least for the next few years. If, however, serious changes take place in either of the two cost dimensions (the amounts and rates of pay for each cost factor) new cost curves will become necessary. The experiment station will construct and publish such curves whenever it is advisable.

Changes are most likely to take place in the construction cost of buildings, rate of salaries, and price of equipment and supplies. If the plant was established in 1925 or prior to that time, interest and depreciation should be calculated as in the above illustration. If, however, the plant was established after 1925, and the cost of constructing buildings and price of equipment have changed, it will be necessary to calculate replacement values according to 1925 prices if the curves in Figure 4 are to be used in the present form. Construction companies and creamery equipment houses are in a position to estimate fairly accurately the extent of any changes since 1925. After the replacement values according to 1925 prices are obtained, interest and depreciation can be calculated as illustrated above. No correction need be made for insurance, taxes, and maintenance, as these elements constitute less than 25 per cent of the total annual building and equipment costs and are less subject to change.

If the general level of the prices of supplies or the salaries of creamery employees has either increased or decreased since 1925, these items for a particular creamery must be adjusted. To illustrate, if salaries or supplies are 25 per cent higher than in 1925, then these items for an individual creamery must be lowered 20 per cent if the curve in Figure 4 is to be used in present form. Or if they have decreased 25 per cent, they must be raised 33⅓ per cent. The secretaries of creamery operators and managers' associations or the district field men of central co-operative creamery associations should be able to give fairly accurate estimates of changes in salaries of employees. Similar estimates for changes in prices of supplies can be obtained from creamery supply houses.

Probable Reasons for High Costs

Volume of business, as illustrated in Figure 4, is an important factor in explaining cost variations, but costs differ widely for creameries with the same volume. For creameries making 500,000 pounds of butter, the difference between the highest and lowest cost is about 0.7 cents per pound, while for creameries making 100,000 pounds, the difference is approximately 3.5 cents. Some creameries making between 250,000 and 300,000 pounds of butter annually have as high costs as others making less than 100,000 pounds.

If a creamery finds that its costs are higher than those for the average creamery with the same volume, it should find out the cause. High costs may be due to any one of the four cost groups. The following summary gives the most common causes of high costs.

Causes of High Building and Site Costs

1. Value of land on which creamery is located, too high.
2. Site too large.
3. Plant built for a large volume of business—not realized.
4. Plant built to provide rental space which is used but little.
5. Plant too expensively constructed—value of appearance of plant overemphasized.
6. Plant poorly constructed in view of its cost.
7. Plant poorly arranged, with much wasted space.

Causes of High Equipment Cost

1. Too much equipment.
2. Too expensive equipment.
3. Kind and capacity of equipment not adapted to needs of plant.
4. Purchase price of equipment too high.
5. Equipment not properly cared for.

Causes of High Labor and Management Costs

1. Too many full-time employees on payroll.
2. Rate of pay too high.
3. Failure to use cheap labor for work requiring less skill.
4. Workmen inefficient.
5. Plant inefficiently arranged.
6. Labor-saving methods and equipment not used.
7. Poor co-operation and division of work between employees—work not systematized.

Causes of High Supplies and Miscellaneous Costs

1. Supplies purchased in too small quantities.
2. Supplies wasted.
3. Inefficient use of fuel.
4. Creamery poorly located, so that drayage costs are high.

CREAMERY MARGINS vs. CREAMERY COSTS

The margins taken by creameries, as discussed earlier in this bulletin, are frequently larger than the cost of operation. These additional margins come about in various ways. Creameries that buy their raw material for cash on delivery often find that the gross profits are more than sufficient to cover costs. Ordinarily, creameries that pool their product do not calculate all their expenses carefully. Instead, they deduct an arbitrary amount per pound of butterfat as a sinking fund to cover unusual expense items. In many cases these sinking fund assessments also provide means for retiring indebtedness and means of expansion. If the margins in excess of costs are retained in the business, they usually build up surpluses which accrue to the equity of the stockholders. While reasonable surpluses are desirable, large surpluses presently result in inequitable distribution between patrons, for it seldom happens that stock ownership is in proportion to volume of product delivered. Carefully managed creameries avoid these inequalities either by paying out patronage dividends in cash, or by issuing certificates of indebtedness. Either of these dividends amounts to additional payments for butterfat. If the creamery uses certificates of indebtedness as a means of financing, provision should be made for a revolving system by which old certificates are constantly paid off and new ones are issued. A careful explanation of this system of financing can not be given in this bulletin.

In some instances the margin taken by the creamery is less than the cost of operation. This practice is sometimes used as a means of disposing of large surpluses built up in the past which are no longer needed. This practice is only temporary and can not continue long, as it would soon result in insolvency.