

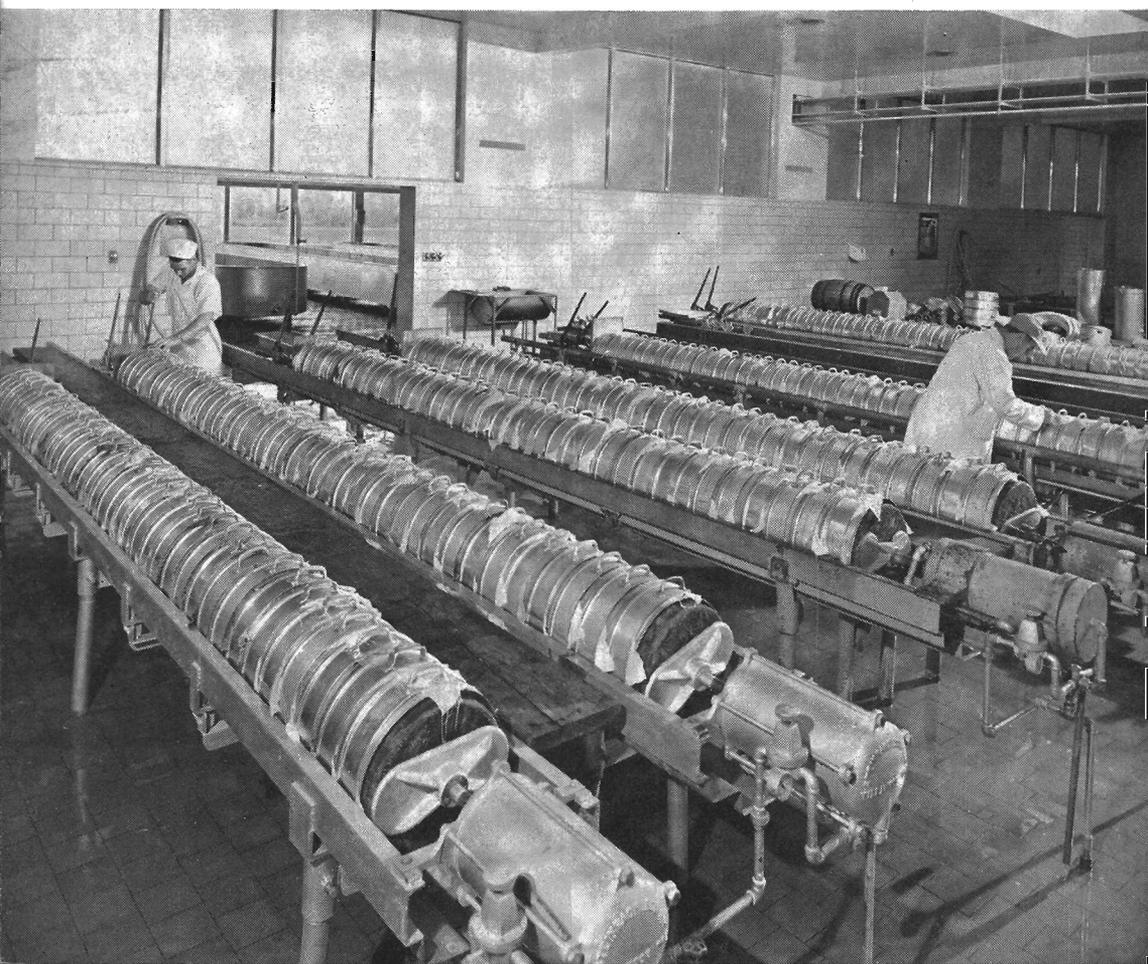
Economics of Cheese Manufacturing *in Tillamook County, Oregon*

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Foreword

The combination of small production units into a single large unit to gain the economics of large-scale production has been one of the noteworthy trends in our economy in the past half century. This bulletin reports a study made in this field. First, the operations of a group of small cheese plants were studied. Then, following a consolidation of six of these into one large plant, the operation of this large consolidated plant was studied. An analysis was made to determine the nature and extent of any economies resulting from the consolidation.

A study of this nature is of interest to the cheese manufacturing industry from the standpoint of assisting in future planning. It will also be of interest to social scientists in that a somewhat unique method of analysis has been used in this study—different in several respects from the typical study into the economies of scale or size of production units.

A handwritten signature in cursive script that reads "F. E. Price". The signature is written in dark ink and is centered on the page.

Dean and Director

Mr. Ray Deaver, Treasurer and others of the office force of the Tillamook County Creamery Association were very helpful in collecting information for this study. Several staff members of the Division of Marketing and Transportation Research, Bureau of Agricultural Economics, gave assistance in developing the methods used in analyzing the results of the study and in preparing the report. Among these were William Bredo, William H. Wallace, and D. B. DeLoach. This study was financed in part by funds provided by the Research and Marketing Act of 1946.

Economics of Cheese Manufacturing

in Tillamook County, Oregon

GORDON A. ROWE¹

THE HISTORY of cheese production in Tillamook County is essentially the story of the Tillamook County Creamery Association. The manufacturing of cheese started in Tillamook County, Oregon, in 1889. Production of cheese was a convenient and economical method of converting locally produced milk into a less perishable form at a time when transportation was still relatively primitive. As cheese could be stored for a reasonable period, shipment to distant markets was made easier, and transportation costs were covered without too serious a burden on producers. By 1902, approximately 40 cheese factories of varying sizes had been established in the county. About half were farm-factory, family-type operations which manufactured cheese from milk produced on one to three farms. Several factories in the county were owned and controlled by producers.

After a time, economic considerations forced several of the small cheese plants to seek more satisfactory methods for processing and marketing their products. These local plants founded the Tillamook County Creamery Association in 1905 as a federation of local cooperatives (Figure 1). With the formation of the Association, an inspector was employed to see that the cheese received from member associations for marketing was uniform and of high quality to meet the demands of consumers. The quality of cheese was maintained by establishing a program to produce high-quality milk and regular inspection of practices and methods used by cheese plants. By 1909, ten local plants, stockholders in the Association, were marketing their cheese cooperatively. Most of the family-type operations disappeared in time or were combined with other plants to get greater volume and further specialization of production.

The Association continued to grow and achieved a very favorable position in its markets by advertising and producing a high-quality, uniform product. By 1949 production of cheese in the Association had increased to an annual volume of 10 million pounds. The number of cheese factories, however, decreased through consolidations. All these plants are now members of the Association, which markets all

¹This study is a contribution to the Western Regional Research Project WM-1. It was conducted under the authority of the Research and Marketing Act of 1946. The author, Gordon A. Rowe, was formerly Research Assistant, Oregon Agricultural Experiment Station, employed on a cooperative basis with the Bureau of Agricultural Economics, U. S. Department of Agriculture.

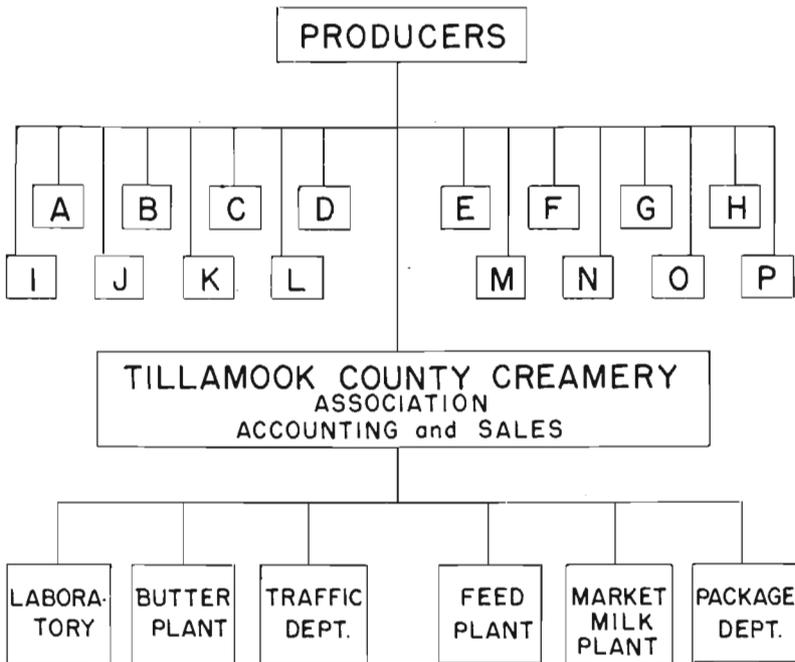


Figure 1. Ownership chart of Tillamook County Creamery Association, January 1, 1947.

the cheese and other products produced by the member cooperatives and performs the other marketing and supply services required by the organizations.

The older plants were built between 1900 and 1920 and were located to serve small, adjacent production areas. The supply area was limited by available means of transportation, and cheese plant equipment was of the type that could be obtained at that time. Since 1940, technological developments in processing, handling, transportation methods, refrigeration, machinery, and changes in utilization of milk have been introduced rapidly. These changes have significantly affected the organization and operation of many marketing organizations, including the Tillamook County Creamery Association and its members. Some of the plant physical facilities in the Association have been in operation for 50 years, and the last local factory was built in 1937.

Changes in the demand for styles and varieties of cheese and in economical utilization of milk have been important to the Association.

In recent years the industry has turned to packaging cheese in small, consumer-sized, rindless packages. The Association is now producing rindless cheddar and club cheese in addition to its standard style of triplets, loaf, baby-loaf, and gems, as shown in Figure 2.



Figure 2. Types of cheese produced by the Tillamook County Creamery Association.

Increased demand for the newer styles and varieties of cheese had enabled the local plants of the Association to make greater returns to producers. However, production of these new products has been hampered by the lack of proper plant locations and facilities.

Changes in population in the Oregon and Washington areas have brought drastic changes in utilization of milk.¹ Before World War II, milk for the fresh market was not shipped out of Tillamook County. Since 1940, however, increases in population in the Portland

¹ See Gordon A. Rowe, *Changes in Milk Utilization Portland (Oregon) Milkshed, 1940-50*, Oregon Agricultural Experiment Station Circular of Information 512, June 1952.

Table 1. PRODUCTION STATISTICS OF THE TILLAMOOK COUNTY CREAMERY ASSOCIATION, 1941-1949

Year	Milk received for manufacturing	Milk received for fluid use ¹	Cheddar cheese manufactured ²	Rindless cheese produced	Club cheese produced ³	Butter manufactured
	<i>1,000 pounds</i>	<i>1,000 pounds</i>	<i>1,000 pounds</i>	<i>1,000 pounds</i>	<i>1,000 pounds</i>	<i>1,000 pounds</i>
1941	94,600		10,959			176
1942	96,681		11,140			174
1943	89,071		9,734			217
1944	93,082		10,133			198
1945	94,721		10,346			130
1946	87,224		9,437			251
1947	94,310		10,508	140		212
1948	91,517	344	10,174	550		193
1949	84,294	18,005	9,380	1,040	18	202

¹ Some direct diversions by members occurred before 1948.

² Includes cheese used in production of rindless and club cheese.

³ Production for October, November, and December.

metropolitan district have brought about an expansion of the milkshed of that market to include Tillamook County. As a result, the Association has diverted some milk from manufacture of cheese to the Portland fluid milk market in order to obtain the highest returns for its patrons. Table 1 shows the utilization of milk received and production statistics of the Association. Although by the end of World War II the Association had increased and improved its services, further adjustments to meet rising costs in processing and marketing had become imperative. Two plans were possible in making these adjustments. The first was to modernize individual plants wherever possible, and to establish new facilities for the necessary additional services being performed. The second was to build one modern multiple-product plant to permit the Association to process and manufacture its products in ways most acceptable to consumers.

The Association adopted the latter plan and built a new centrally located plant to provide more efficient methods for handling milk for the fresh milk market, for producing new styles and varieties of cheese, for processing, storing, and handling of other new products now marketed by the Association. Six local plants producing cheddar cheese consolidated their operations and built a modern cheese plant as a part of the new consolidated creamery establishment.

This program of the Association, including consolidation of the six cheese plants, affords an unusual opportunity to study at first hand the economic effects of consolidating many of the processing and marketing operations into one modern, centrally located dairy plant.

Inasmuch as other dairy areas in the United States have similar problems facing them, the information derived from this study should

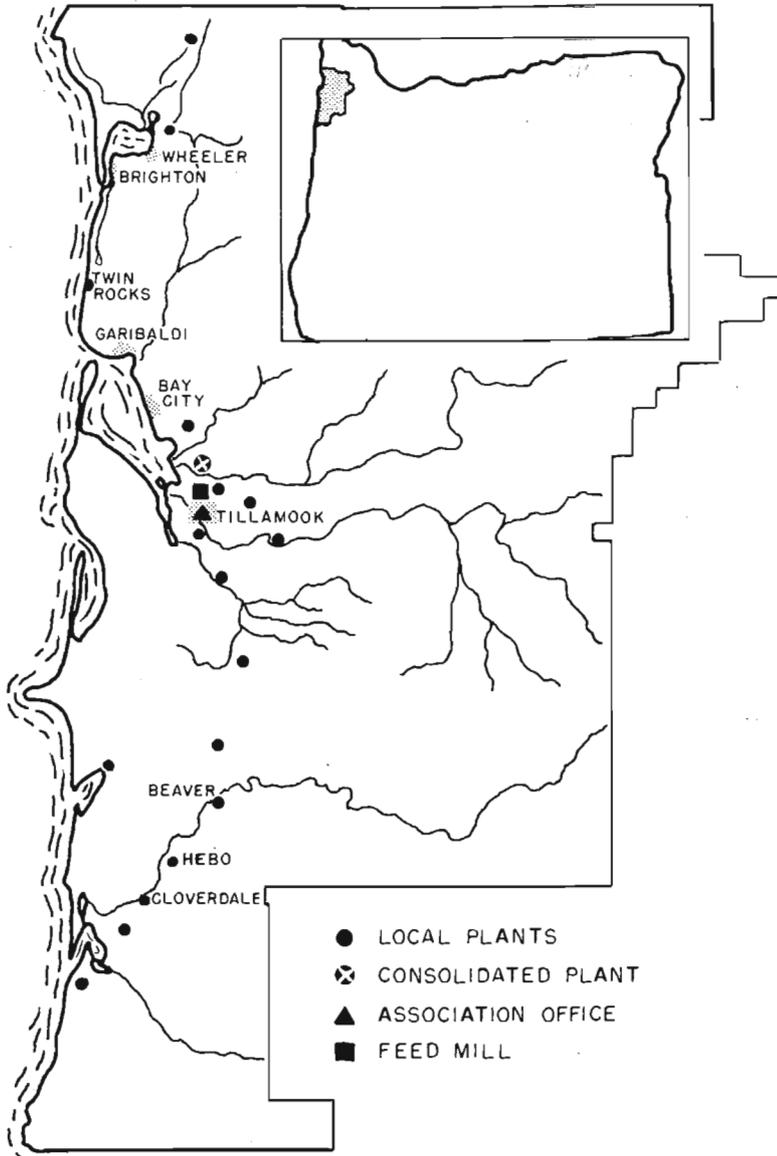


Figure 3. Location of facilities of the Association and local plants in Tillamook County.

be of direct interest to dairymen and dairy marketing agencies throughout the United States.

Figure 3 shows the location of the various plants of this Association and the relative location of the county in the State. The structure of ownership and the facilities of the Tillamook County Creamery Association are presented in Figure 4.

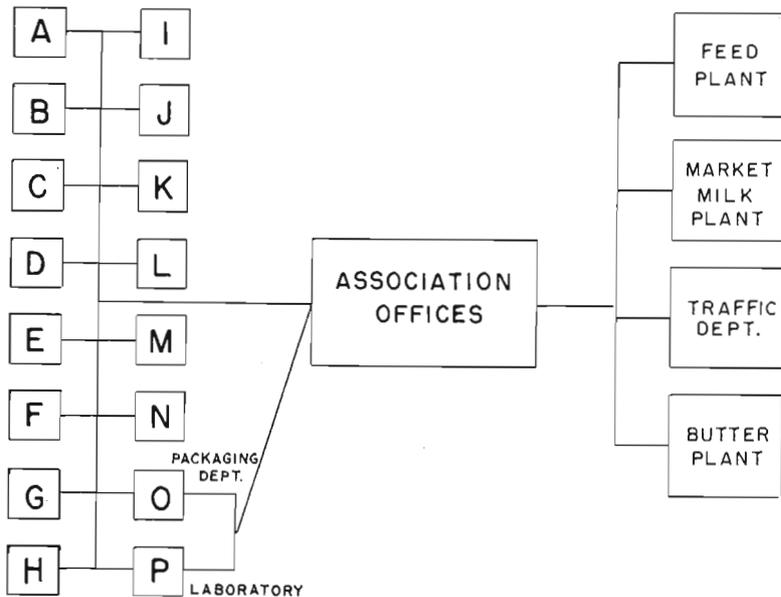


Figure 4. Facilities plan of the Association, January 1, 1948.

Manufacturing Costs of 16 Specialized Cheese Plants

A study to determine the costs of manufacturing cheese has been conducted with the objectives of establishing the economic basis for consolidation of cheese plants and other operations and of studying economies of scale of operations.

Two methods were used to determine the relationship of unit costs to volumes. One involved a study of costs as they have been reported for the 16 plants over an 8-year period, 1941-48. The other developed after certain adjustments were made in the physical plant, cost rates, and variable costs for 5 of the 16 plants. The adjustments were made to eliminate certain variations existing in costs among the plants studied which were not necessarily related to differences in size.

Table 2. UNIT COST OF MANUFACTURING CHEESE, 1941-1948

Plant	Average annual cheese production 1941-48	Labor	Supplies	Plant repair	Power lights and water	Insurance	Depreciation	Taxes	Donations, fees and expenses	Miscellaneous costs	Total cost per pound
	Pounds	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
A	178,297	2.25	1.53	.18	.05	.09	.24	.2310	4.67
B	194,170	2.25	1.31	.30	.07	.08	.17	.18	.03	.09	4.48
C	248,409	2.11	1.49	.27	.08	.11	.14	.13	.03	.08	4.44
D	263,175	1.86	1.27	.22	.06	.08	.20	.12	.03	.07	3.91
E	375,016	2.03	1.30	.31	.15	.07	.19	.14	.02	.06	4.27
F	437,527	2.13	1.31	.26	.09	.07	.11	.14	.03	.07	4.21
G	468,465	2.11	1.24	.19	.11	.08	.11	.13	.04	.06	4.07
H	585,506	1.96	1.17	.15	.11	.06	.17	.12	.03	.05	3.82
I	586,839	2.02	1.09	.18	.12	.06	.09	.10	.05	.06	3.77
J	703,473	2.05	1.10	.24	.13	.06	.11	.11	.04	.06	3.90
K	777,323	1.84	1.22	.24	.09	.06	.13	.11	.02	.05	3.76
L	784,462	2.01	1.15	.26	.10	.06	.10	.14	.04	.05	3.91
M	861,371	1.94	1.22	.21	.10	.05	.11	.13	.04	.06	3.86
N	949,212	1.81	1.07	.16	.11	.06	.20	.11	.02	.05	3.59
O	1,031,760	1.78	1.05	.08	.11	.04	.13	.10	.02	.05	3.36
P	1,569,443	1.71	1.12	.19	.10	.04	.15	.14	.03	.06	3.34
All plants	10,015,988	1.92	1.17	.20	.10	.06	.14	.12	.03	.06	3.80

In the first analysis, manufacturing costs were determined from plant records. Weighted average costs for the 8-year period are shown in Table 2, with corresponding average volumes for the same period. Certain administrative costs, such as bookkeeping, and practically all marketing costs incurred after the cheese is made, are absorbed by the central marketing association and prorated among the members. They are not included in this study of costs.

Labor Costs

Labor costs include only the costs of the functions performed in the manufacturing of cheese, from receiving milk to shipping the final product. These costs were adjusted to compensate for irregularities in the weighted averages for the 8-year period resulting from diverging trends in annual production at the individual plants, together with sharply rising wage rates. Annual total costs of labor for each plant were divided by the ratio of annual unit labor cost for one year over the average annual unit costs of labor of all plants for the 8-year period. These adjusted annual total costs were then used in lieu of actual costs for computing the 8-year average unit labor costs for each plant.

Unit labor costs decrease with increases in average plant volume. This decrease is as much as 24 per cent between Plants A and B and Plant P as shown in Table 2. There is a difference of 0.54 cents per

pound of cheese manufactured between the unit costs of labor for the smallest and the largest plants, and 0.21 cents between the average unit costs of labor in the average of all plants and for the largest plant, P.

There are some variations from the normal tendency for unit labor costs to decrease with increases in volume for the plants in Table 2. Plant D, for example, shows relatively lower unit costs than Plant C. These deviations are largely due to differences in the efficiency of labor in the various plants. Although methods of manufacturing cheese are the same in all plants, some plants make more efficient use of labor. A factor affecting efficiency in the use of labor is the practices and requirements of the head cheesemaker regarding plant operations which are not related to volume. A further discussion of the utilization of labor is given in a later section.

Supplies

Supplies as defined by the accounting methods of the Association include those necessary in the manufacture of cheese, such as rennet, salt, color, bandages, washing powders, and others. Costs of fuel are also included in "supplies" in Table 2.

Inclusion of fuel costs, which normally decrease per unit of product with increases in size of plant, probably accounts for a large part of the tendency of these unit costs to decline, as shown in Table 2. Deviations from the tendency of the unit costs of supplies to decrease with increases in size is more apparent than for unit labor costs. This is because of the greater variation in the use of certain supplies by the plants.

Plant Repairs

Plant repairs are the third most important cost item in the manufacture of cheese as shown in Table 2. Unit costs of repairs tend to decrease with increases in size of these plants. The variations in charges for plant repairs are largely accounted for by differences in standards of maintenance of buildings and equipment, and in the methods by which repairs are made.¹ Some plants made only the minimum repairs necessary to their equipment and buildings, and attempted only to meet the minimum standards required by health authorities and for general appearance. Plant O showed the lowest unit costs, but it maintained its facilities at or below a minimum level of efficiency and appearance.

¹ In some plants the cheesemakers made the repairs while in others these repairs were made by other employees or by repair companies.

Power

Power costs include water and electricity. Many cheese plants owned their own water systems and incurred no direct expenditure for costs of water. A major proportion or all of the costs of power were for electricity.

The scale of operations is not directly reflected in production costs, as might be expected (see Table 2), but this may be caused by different uses of power in the plants. In most of the small plants, no refrigeration is used in the curing rooms, while in most of the larger plants, these rooms are refrigerated mechanically.

The cost of water varies among the various plants. For example, Plants N, O, and H pay fixed annual water charges of \$240.00, \$360.00, and \$50.00, respectively; Plant P has metered water with annual costs of approximately \$540.00; Plant A owns its own water system, an investment of \$1,526.92 with annual estimated costs of \$60.00. Water costs per pound of cheese produced vary among them from .03 cents for Plant O to .01 cent for Plant H.

Insurance

These costs include the costs of insurance on buildings, equipment, stocks of cheese and public liability. Insurance charges are based on a percentage of the new replacement costs¹ of the buildings and equipment. The new replacement value of equipment and buildings in 1947 decreased from 14 cents per pound for Plant A to 6 cents per pound of cheese for Plant P. This would be reflected directly in decreasing insurance charges. Some of the local plants own houses for the use of their cheesemakers. This accounts for some of the variations in insurance costs. The Association maintains a blanket policy for all the local plants, and therefore the rates are the same for all plants in the group.

Depreciation

Depreciation is charged on buildings and equipment. Unit costs of depreciation decline with increases in plant size. The deviations are due principally to the age of existing buildings (not on new replacement value), the rate at which equipment has been replaced, and the volume of cheese manufactured. Plant N, for example, was constructed relatively recently. Plant H has a comparatively larger

¹ New replacement value of buildings and equipment is the estimated replacement cost of the physical assets of local plants as of January 1, 1947.

investment in buildings per unit of product than other plants of similar size.

Taxes

Unit costs of taxes decrease in the same way as insurance and depreciation with increasing size of these plants, as these costs are in part directly related to capital investment. In the plant accounts for taxes, costs of unemployment insurance, workmen's compensation, and medical insurance are also included. These costs have the same effect as wage costs.

Variations in unit costs of taxes are partly due to variations in tax rates levied on the various plants. Plant P, for example, has city taxes included in its costs which other plants do not have. Plant C must pay a water port tax. Tax levies for the various school districts also vary from district to district in which the various plants are located.

Directors Fees and Expenses

These costs are self-explanatory. Plant A had charges of only \$40.00 for the 8-year period. The board members took care of their own expenses. The scope of the activity of the board of directors appears to have been independent of the size of the plant, and consequently there is no apparent relationship between volume and unit costs for these items.

Miscellaneous

These costs are principally dues and other costs of participating in the various industry organizations and of charity or support of other community projects.

Total Unit Costs

Total unit costs of manufacturing cheese tend to decrease with increases in size of plant, as shown in the analysis of the reported costs for this group of cheese plants. This decrease is as much as 28 per cent between Plants A and P. These cost data tend to support the analytical results of others on economies in the scale of operation of dairy plants.¹

¹Bressler, R. G., *Economies of Scale in the Operation of Country Milk Plants*, New England Research Council on Marketing and Food Supplies and U. S. Department of Agriculture and Columbia Basin Joint Investigations, Agricultural Processing Industries, Problem 24, Bureau of Reclamation, U. S. Department of the Interior.

Certain estimated economies from consolidation or development of large plants may be indicated from this first analysis of costs. The average annual volume per plant in the Association during this period was 626,000 pounds of cheese. This was considerably higher than the average for all cheddar cheese plants in the United States,¹ which averaged 484,000 pounds in 1948.

Savings possible to this Association, assuming that the average unit costs of labor were equal to that for the low plant cost, would be 0.21 cents per pound of cheese, or \$21,000 annually for the Association's annual production.

Assuming the influence of economies in the scale of operation to show a greater difference in unit costs between the average-sized plant in the United States and plants equal to the size of Plant P, indications are that the total reduction in labor costs and in other costs of manufacturing by increasing the size of cheddar cheese plants in the United States equal to Plant P could be of great economic significance.²

Adjusted Costs of Manufacturing Cheese

The objectives of determining adjusted costs of manufacturing cheese are twofold. The first is to eliminate some of the variability not related to size of plant which was shown in the preceding section. The second is to establish an economies-of-scale curve that may be used as a rough guide to indicate possible efficiencies between plants and within the industry.

From the foregoing discussion of the relationship between volume and unit costs, it has been shown that economies do exist, but that there are certain variations from the general tendency. These may be due to many factors, such as varying efficiency in the use of labor and supplies, and variations in rates paid by local plants for similar services or items.

In order to determine the scale of operation, certain adjustments in the input of facilities, equipment, taxes, and other items are necessary to eliminate the variations in unit costs not related to size.³ These adjustments are made for Plants A, E, H, O, and P. The

¹Production of Manufactured Dairy Products, 1948, Bureau of Agricultural Economics, U. S. Department of Agriculture.

²Certain economies and diseconomies of scale would occur and may or may not offset each other if average plant size were increased.

³For a discussion of these procedures see, "Research Determination of Economies of Scale," R. G. Bressler, Jr. *Journal of Farm Economics*, Vol XXVII, No. 3, (August 1948) pp. 526-539.

assumption used in making adjustments for these plants are as follows:

▶ The output of the plant is established at 50 per cent of its maximum capacity based on a single-shift operation.¹ Yield is assumed to be 11 pounds of cheese per hundredweight of milk received.

▶ The amount of floor space in actual use in the various processing rooms has been adjusted to conform to average standards for plants of given capacities.²

▶ Storage space for cheese is allowed for a holding period of 30 days in the plants.

▶ Costs of building construction per square foot of floor space have been adjusted to uniform construction standards, with allowances for differences in size of plants.

▶ Equipment in use in the plants is adjusted to make it commensurate with requirements of plants of varying sizes.

▶ Variable costs are placed on a comparable basis by using uniform cost rates, such as one schedule of electricity rates for all the plants.

▶ Rates for depreciation, taxes, etc. are assumed to be the same for all plants.

Comparable adjusted costs were developed for the five plants whose annual volumes range in size from 200,750 pounds for Plant A to 1,405,250 pounds of cheese for Plant P. Only variations in costs among plants relating to size are shown.

Adjusted Fixed Costs

Fixed costs of cheese manufacturing plants, as used herein, include depreciation, insurance, interest on investment, repairs and maintenance for building, machinery, equipment, and costs of land. Table 3 shows the reported and adjusted investment in buildings, machinery, and equipment for cheese plants of various sizes in the sample.

The items include all the major prices of equipment required for the manufacture of cheese with the exception of that required for pasteurization. The costs of the buildings are based on costs varying from \$3.20 to \$4.20 per square foot, and the floor space required has been adjusted from the basis of present requirements in

¹Plants operated at approximately 50 per cent of capacity, largely because of seasonal variation in milk receipts.

²See page 15.

Table 3. ADJUSTED PRODUCTION, ASSETS, AND UNIT FIXED COSTS OF MANUFACTURING CHEESE

Item	Plants				
	A	E	H	O	P
Average volume, pounds of cheese, 1941-48	178,298	376,014	585,506	1,013,760	1,569,443
Adjusted volume, pounds of cheese	200,750	401,500	602,250	1,003,750	1,405,250
Number of cheese vats (10,000 pounds)	1	2	3	5	7
Floor space, square feet	3,010	5,424	5,796	9,878	13,048
Adjusted floor space, square feet	2,525	3,889	5,083	8,192	10,080
Construction costs, dollars per square foot	\$3.80	\$2.94	\$3.27	\$3.67	\$3.50
Adjusted construction dollars, per square foot	\$4.20	\$3.80	\$3.50	\$3.30	\$3.20
NRV of cheese factory building ¹ , dollars	\$11,450.95	\$15,996.00	\$18,958.17	\$36,242.80	\$45,679.49
Adjusted NRV of cheese factory building, dollars	\$10,605.00	\$14,778.20	\$17,790.50	\$27,033.60	\$32,256.00
NRV of machinery and equipment, dollars	\$12,866.54	\$20,765.14	\$26,898.11	\$29,863.23	\$55,463.50
Adjusted NRV of machinery and equipment, dollars	\$11,045.82	\$15,034.08	\$21,452.68	\$32,542.10	\$44,594.13
Land area, acres	1	1	1.5	2.5	1
Adjusted land area, acres	0.11	0.18	0.23	0.38	0.46
Taxable value per acre	\$2,210.00	\$2,670.00	\$3,640.00	\$6,080.00	\$8,440.00
Adjusted taxable value per acre	\$3,000.00	\$3,000.00	\$3,000.00	\$3,000.00	\$3,000.00
Annual cost, in dollars:					
Building @ 12%	\$1,374.11	\$1,773.38	\$2,134.86	\$3,244.03	\$3,870.72
Machinery and equipment @ 20%	\$2,249.16	\$3,042.62	\$4,290.52	\$6,508.42	\$8,915.83
Land	\$ 16.37	\$ 25.45	\$ 33.26	\$ 53.59	\$ 65.95
Total annual cost	\$3,639.64	\$4,841.45	\$6,458.64	\$9,806.04	\$12,852.50
Fixed manufacturing cost, cents per pound	1.81	1.21	1.07	0.98	0.91

¹ NRV is the new replacement value including installation costs of building, machinery, and equipment.

these plants. Curing-room space is calculated to allow for a 30-day period in the plant for drying and curing on the basis of 66 $\frac{2}{3}$ pounds of cheese per square foot of floor space.

All fixed annual charges on buildings and equipment are 12 per cent of the investment in buildings and 20 per cent of the investment in equipment. These annual charges comprise the following items:

	Buildings Per cent	Equipment Per cent
Depreciation	3.0	10
Insurance	1.5	1.5
Taxes	2.25	2.25
Interest on investment	3.25	3.00
Maintenance and repairs	1.5	3.25
Total	12.00	20.00

Depreciation is based on an estimated life of 33 years for buildings and 10 years for equipment. Fire insurance costs are at the rate of \$4.184 per thousand for two years. This is equal to 1.46 per cent of the insurable value per year. Tax levies used for these plants are 30.1 mills for county and state taxes, and 17.4 mills for school-district taxes. Assessed values for taxation purposes are 50 per cent of actual values, and are approximately equal to 2.25 per cent of the new replacement value. Interest on investment for buildings is equal to compound interest at 5 per cent on the unpaid portion for 33 years, or a weighted average of approximately 3.25 per cent. For equipment, interest on investment is for the 10-year period, and is estimated at a weighted average of approximately 3.0 per cent. Maintenance and repairs have been established at 1.5 and 3.25 per cent for buildings and equipment, respectively. The latter rates reflect reported costs in these plants and depreciation studies of the Bureau of Internal Revenue.

Adjusted Unit Variable Costs

Adjusted unit variable costs are shown in Table 4 for the five plants, A, E, H, O, and P. These costs represent an adjustment of the reported costs of these or other plants in the group.

Table 4. ADJUSTED UNIT VARIABLE COSTS PER POUND OF MANUFACTURING CHEESE, POSTWAR PERIOD

Cost Item	Plants				
	A	E	H	O	P
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
Labor	2.89	2.55	2.34	2.17	2.15
Electricity ¹	0.10	0.07	0.06	0.04	0.03
Fuel ²	0.45	0.34	0.26	0.19	0.18
Supplies	1.00	0.99	0.98	0.97	0.97
Total	4.44	3.95	3.64	3.37	3.33

¹ Consumption is equal to 4.5, 4.38, 4.28, 3.62, and 3.54 kilowatt-hours per 100 pounds of cheese, for plants A, E, H, M, and P, respectively.

² Consumption is equal to 10,100, 7,500, 5,750, 4,250, and 4,000 BTU's per pound of cheese, for plants A, E, H, M, and P, respectively.

Costs of supplies were determined from reported costs for plants of given size by excluding costs of fuel. Costs of fuel were developed from the reported use of fuel in BTU's for the 1944-48 period for which data were available. Costs of electricity were derived from the reported use of electricity, in kilowatthours, for the 1946-48 period for which data also were available for the different plants in the Association. Electricity requirements include lights and

power for the various items of machinery used in the cheese plants. Costs of labor were developed from an analysis of labor records for the 1941-48 period.

Adjusted Total Unit Costs

Adjusted total unit costs for manufacturing cheese in the five plants, A, E, H, O, and P, were 6.25, 5.16, 4.71, 4.35, and 4.34 cents per pound, respectively. The economies of plant scale are presented in Figure 5 in the form of the long-run planning curve. This curve is

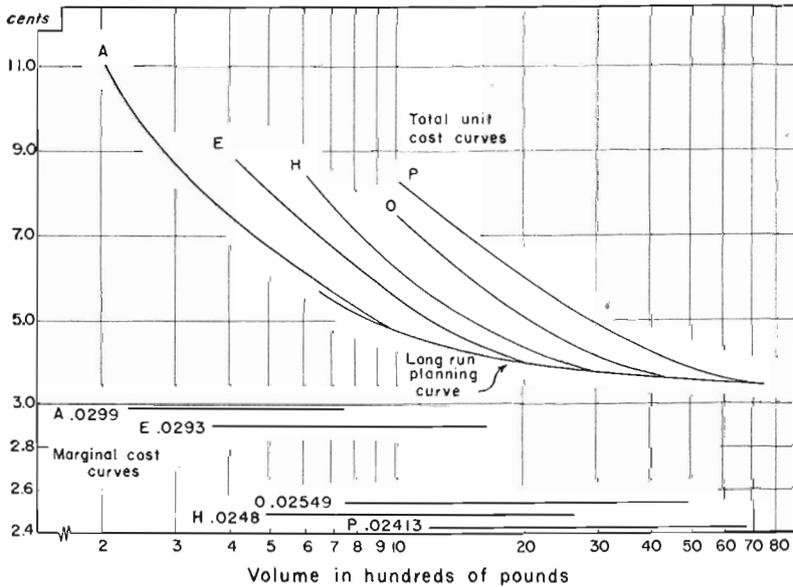


Figure 5. Average marginal total unit cost curves and long run planning curve.

determined as the tangent to the cost-volume curves for each of these five plants. The long-run planning curve shows the lowest costs of producing a pound of cheese, assuming a choice is available in the size of plant. This is the situation that prevails when a firm is making plans for plant construction or modification and wishes to build the most economical capacity in line with the expected market.

The marginal unit cost curves for these plants, shown in the lower part of Figure 5, represent the additional cost associated with the production of an additional given volume of cheese. The result

is that marginal unit costs for each of these plants are horizontal straight lines, meaning that the additional cost of producing an additional unit volume remained unchanged for the normal operating range of the plant. It should be noted that the average unit costs of production decline with an increase in output such as may be associated with a seasonal increase in milk receipts. As receipts decline from the flush to the short period of the year, the converse is true.

From the long-run planning curve it may be concluded that there are economies in the scale of operation in cheese plants. The minimum point on the long-run planning curve of manufacturing costs appears to lie beyond the range of volumes for the plants included in this study. It should not be inferred that the optimum sized plant that is desirable should be larger than Plant P, as other diseconomies and possibly some economies must be taken into consideration. With respect to diseconomies, of most significance are costs of assembling which normally increase directly with increases in plant volume, and which may result in an optimum sized plant at a volume less than that of Plant P.

It should be noted that the marginal costs of manufacturing cheese are low in relation to average total unit costs. This is the result of very high fixed costs and very low variable costs of operation. Marginal unit costs are not only low but differ little between plants of various sizes ranging between $2\frac{1}{2}$ to 3 cents per pound of cheese.

Labor Costs

A study of input-output relationships of this factor of production not only provides the basis for establishing the labor costs of the hypothetical plants; it may also be of value to management. An analysis was made of labor inputs derived from payroll records for the period 1941-48.

The following series of figures show the relationship between labor inputs and cheese production. Variations in volume for individual plants are caused by seasonal fluctuations. These figures show that indivisibility of labor is apparent in the smaller plants. The addition of a second employee in Plant B at 500 pounds of cheese per day produces a definite effect on labor requirements, resulting in a discontinuous cost curve for this plant. In larger plants, the proportional significance of an additional employee is not so important. This may be explained partially by the flexibility of output of workers. Each worker has a normal capacity to produce 500 or more pounds of cheese per day, depending on the size of the plant. In small plants such as Plant B, output of the one worker cannot be

expanded sufficiently to produce a continuous relationship. In large plants such as Plant N, the sum of the output of each worker may be expanded sufficiently before an additional worker can maintain a continuous relationship with increases in volume. Apparently this is important in lowering the costs for larger plants when there is a definite seasonal pattern of milk production.

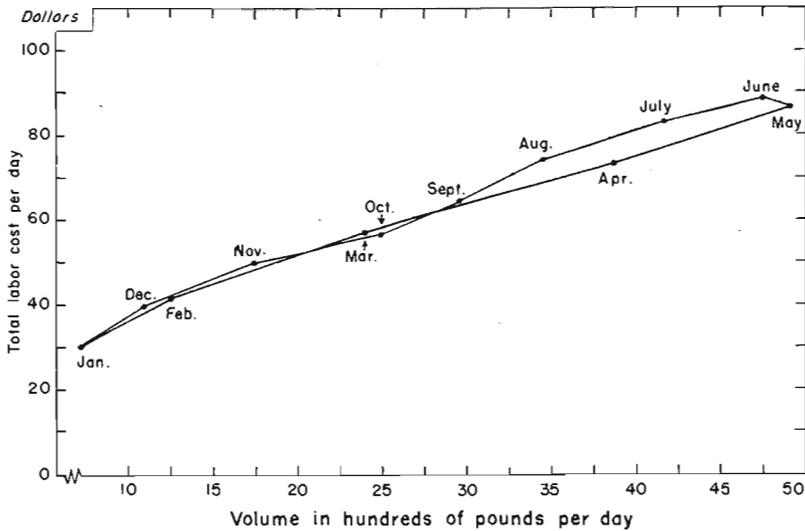


Figure 6. Seasonal labor utilization pattern for Plant O.

The character of seasonal labor utilization is shown in Figure 6 for Plant O. It is observed that the plants are slow in adding labor, when production and receipts are increasing seasonally and also slow in taking off labor as production declines. The result is a lower labor cost function when daily production increases from January to May. This more efficient function is presented in Figure 7.

Total costs of labor per day for cheese manufacturing are presented in Figure 8. It is noted that the total cost curves for each plant are straight lines. The slope is not steep and in general seems to decline with the size of the plant. This indicates that the marginal unit costs are low and decline with an increase in plant size, as can be seen in Figure 9. A study of the average unit cost curves of this figure shows that substantial decreases in the cost of labor occur between the short and the flush season of production as the volume of

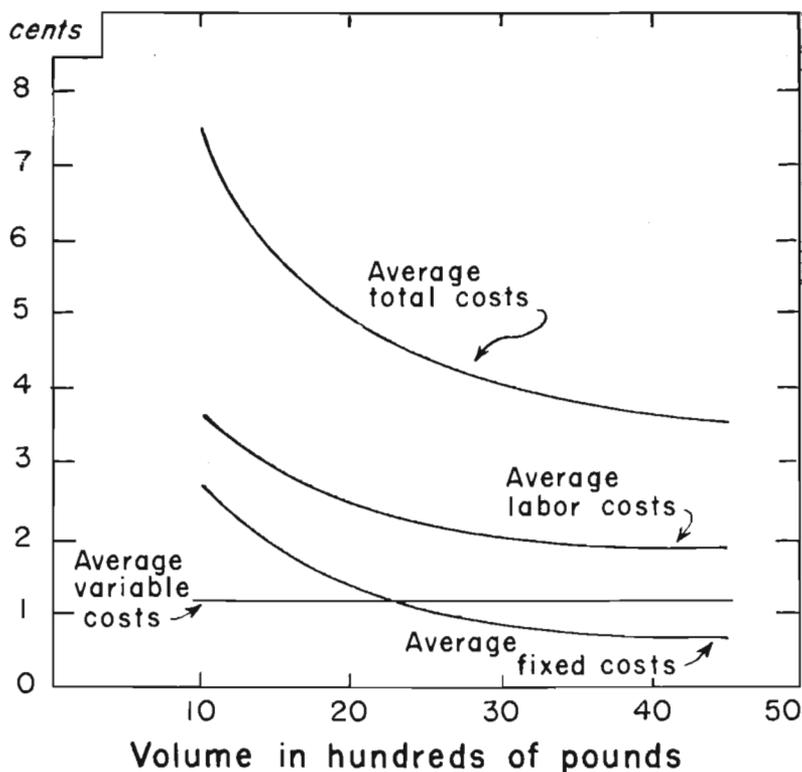


Figure 7. Average total unit costs, fixed costs, labor costs, and other variable costs of manufacturing per pound of cheese, hypothetical Plant O.

receipts at the plant increases. The seasonal range in cost is approximately 2 cents irrespective of the size of plant.

In developing the average labor cost curves, the existing wage scales for plants were used. The wage scales were varied in order to take into consideration increasing output in larger plants. If a single wage scale had been used for all sizes of plants, the differences in labor costs between small and large plants would be found to be due, partially, to imperfections in the wage agreement. These wage scales take into consideration the number of man-days worked per day in the plant. Each wage scale is based on a range in plant output. Thus, each of the plants for which cost curves are presented in Figure 8 had a different wage scale. As the size of plant increases, therefore, the increase in the level of the wage scale reduces the effects of increasing productivity associated with the large plants.

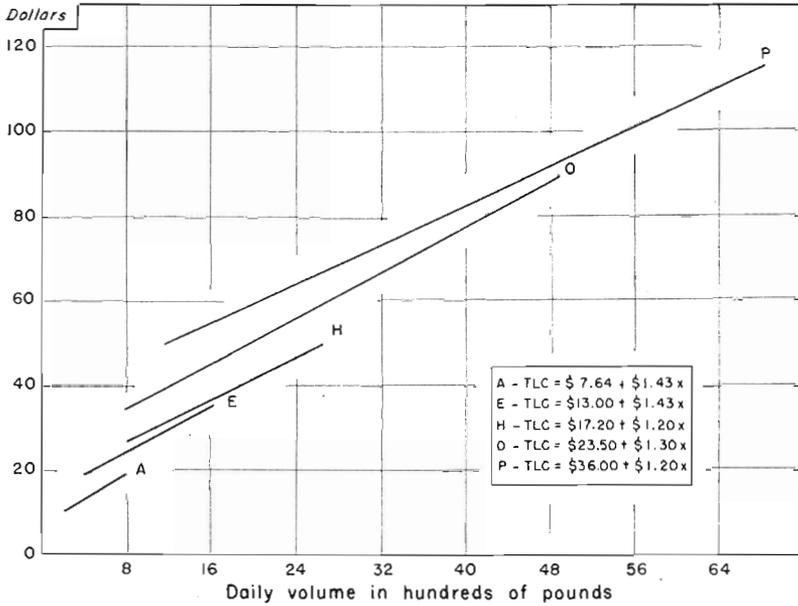


Figure 8. Total labor cost curves for five hypothetical plants.

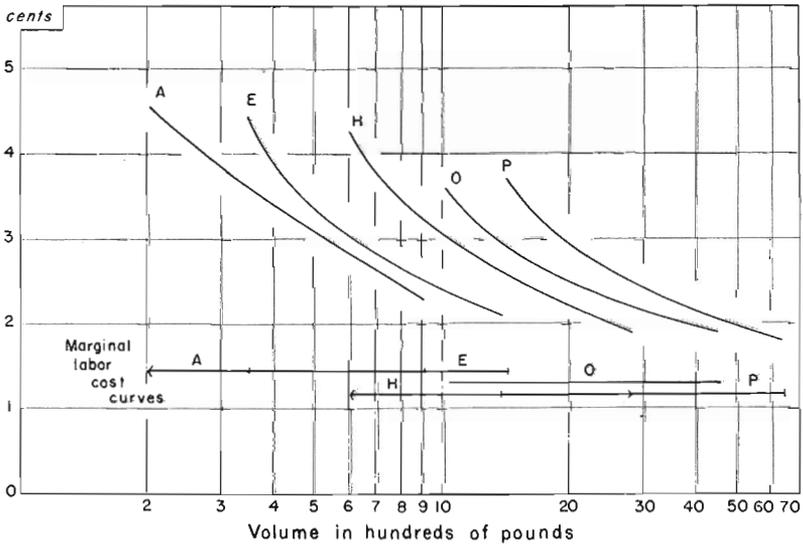


Figure 9. Average unit labor cost and marginal labor cost curves for five hypothetical plants.

Consolidation

Consolidation of dairy manufacturing plants may have several purposes. One may be to increase the size of the plant, thereby lowering unit costs of manufacturing. The economies effected by increasing the size of the dairy plant have been shown above. Another purpose of consolidation is to enable the marketing organization or organizations to utilize new methods of processing and handling milk, dairy products, new types of machinery, and building construction. These facilities may provide for additional functions, and in some instances may add flexibility.

The consolidated plant of the Association incorporates many of the changes that have become necessary and desirable to adopt in the processing and handling of cheese and other dairy products. The new plant has replaced Plants D, H, J, N, O, and P. The new consolidated manufacturing plant includes a cheese plant; a butter plant; a market milk plant that also produces cottage cheese and ice cream; a whey plant; and facilities for the packaging of rindless and club cheese. The new plant also provides the Association with its own storage facilities, eliminating the need for storing cheese in commercial facilities at terminal markets. In addition, there are facilities for icing refrigerated cars which was previously done in Portland, Oregon, the nearest icing station. The new plant is located between a railroad and a principal highway, giving it improved transportation facilities.

Cheese Plant

Many changes have been incorporated in the cheese plant which physically or economically were not possible in the older plants. Capacity of the cheese plant is approximately 26,000 pounds of cheese per day, based upon a single-shift operation. Flexibility has been provided for, however, in order to facilitate a two-shift operation by adding the necessary items of equipment.

The consolidated plant provides for considerable changes in methods of receiving milk compared to the methods employed in the 16 old plants. These are illustrated in Figures 10, 11, 12, and 13. Manual operations have been eliminated to a large extent in the new plant and more than one truck may be unloaded at one time. Grading is conducted at a considerable disadvantage in the local plants, as no space or position is provided for conducting several tests required in an adequate grading program. Under the old system, producers washed their own cans. With the use of can washers in the new plant, it is possible that the quality of milk received will be improved because of more efficient washing of cans with a can washer.

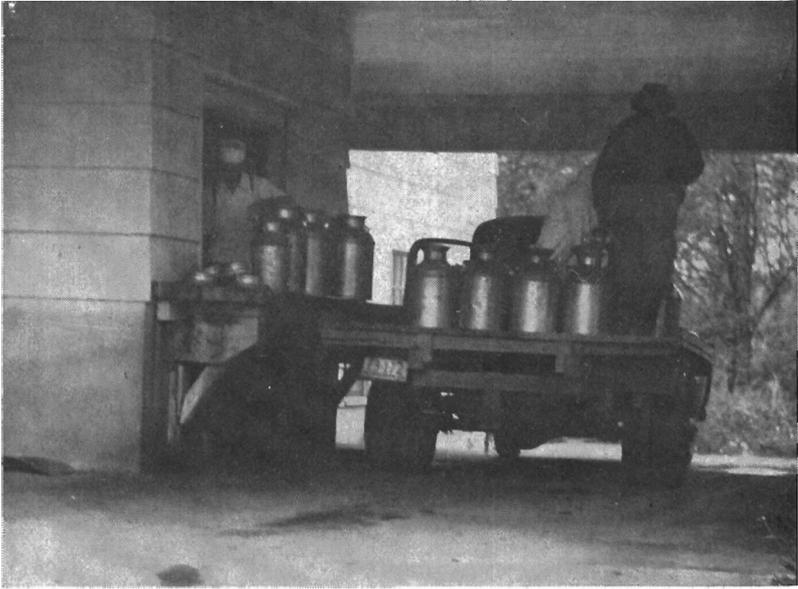


Figure 10. Milk receiving platform at local branch creamery.

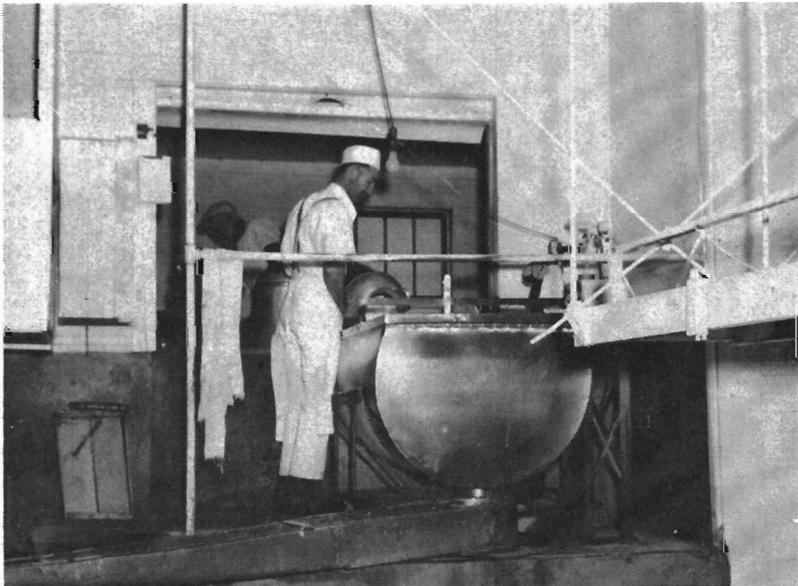


Figure 11. Milk receiving room at a local plant.

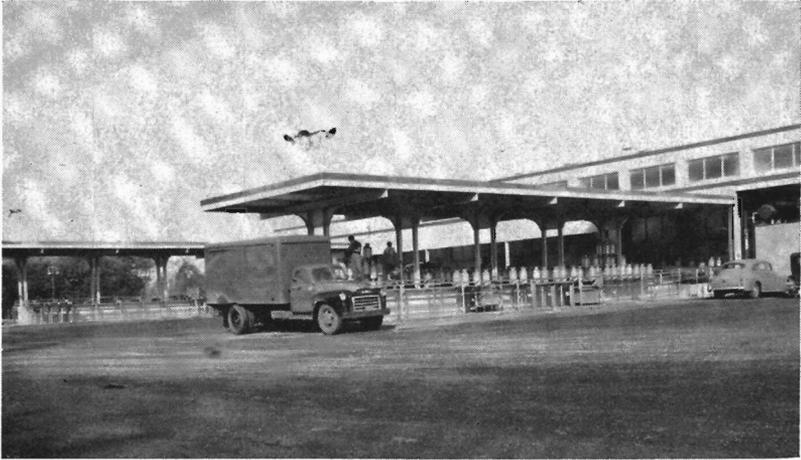


Figure 12. Milk receiving lines at the consolidated creamery.

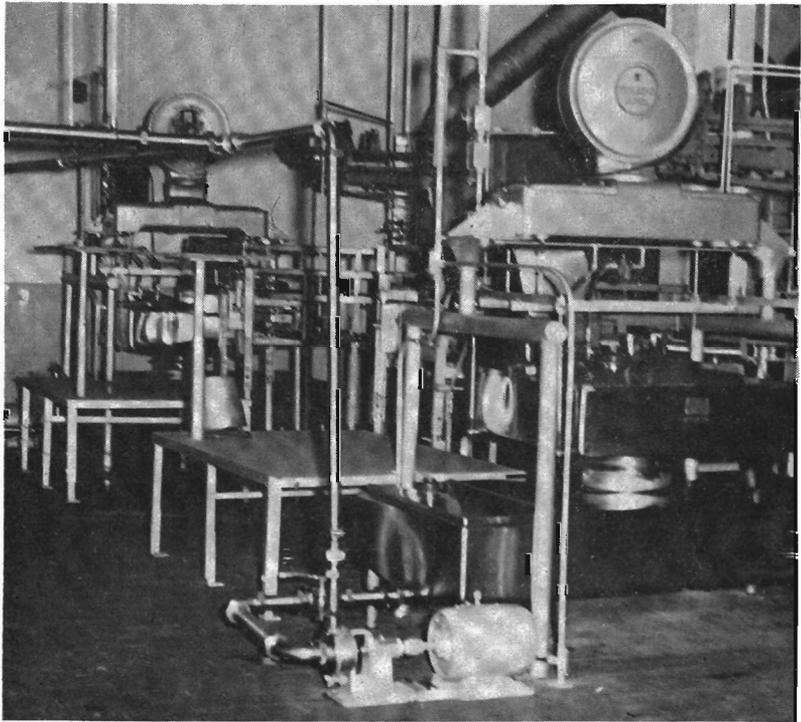


Figure 13. Milk receiving room at the consolidated plant.

Storage Operations

Storage facilities are provided in the new plant for the storage of more than three million pounds of cheese for aging. The greatest innovation in these facilities is in the method by which the cheese is stored for aging. Stalls have been constructed in rooms which hold pallets loaded with approximately 2,000 pounds of cheese. These pallets may be tiered three high as shown in Figure 14. In this method of storage, it is possible to store approximately 850 pounds of cheese per square foot of floor space, while in the older method of storing cheese on shelves about 65 pounds of cheese could be stored per square foot of floor space.

This method of storage permits the use of a lift truck in handling cheese, not only in storage operations, but for use in icing



Figure 14. Storage of pallets by the new method in consolidated plant.



Figure 15. Loading cheese on freight cars at the consolidated plant.

railroad cars and transporting the cheese to the car door as shown in Figure 15. Cheese may be moved into storage and among the various points in the plant, by the use of pallets.

Pallets are also used in the handling of supplies in the new plant, such as salt, paraffin, and packaging materials normally purchased in carload lots.

Package Cheese Operations

Previously the packaging operation, which is relatively new in the dairy industry, was carried on in Plant O. Cheese had to be transported from local plants to storage facilities in one location, then to the packaging operation at Plant O, and then returned to storage. Under the consolidated plan of organization, practically all the operations in the production and packaging of small, consumer-sized units of cheese are carried out in one plant. Also, new machinery and equipment provide for more efficient performance of the function. The room is conveniently located with reference to the cold-storage and hot rooms.

Other Operations

As noted previously, the fluid milk, butter, laboratory, and whey-condensing operations have been incorporated in the new plant (Figure 16). Certain benefits from consolidation of the enterprises,

CHEESE DEPT.	PACKAGING DEPT.	BUTTER PLANT	LABORA- TORY	COLD STORAGE
A B C D				
E F G H				
I J K L	WHEY	MARKET	TRAFFIC	
M N O P	CONDENSERS	MILK PLANT	DEPT.	

CONSOLIDATED PLANT

Figure 16. Proposed plan of consolidation of all the facilities of the Association in the consolidated plant.

in addition to required changes, are being achieved. Surplus milk from the fluid milk operation may be easily diverted to manufacture of cheese for example. All operations benefit from a larger and more efficient power operation.

Evaluation of Consolidation

An analysis of operations for 1950 was made to measure the economic effects of consolidation. It must be recognized that certain beneficial results, such as those on quality, are not measurable. The results of these operations, with certain limitations, may be compared with those of the hypothetical and unconsolidated plants. Table 5 shows the balance sheet and statistical information of operations for 1950 as reported by the Association.¹

Total, average, and marginal cost curves are presented for the consolidated plant in Figure 17. Based on preliminary data on operations during part of 1950, average labor costs for the consolidated plant behaved similarly to the other plants continuing to decline with every increase in the use of plant capacity. These data show that

¹ Adjustments were made in labor inputs to exclude certain personnel who were performing advertising and sales functions rather than a production function!

Table 5. INVESTMENT AND UNIT COSTS FOR 1950

Investment or cost item	Investment	Cost per pound of cheese produced
<i>Fixed assets</i>		
Land	\$ 6,320.64	\$ 0.32
Land Improvement	14,000.00	
Buildings	605,344.36	
Machinery & Equipment	290,120.05	
Total investment	\$915,785.05	\$18.94
<i>Operating costs</i>		
Labor		\$0.0221
Supplies0080
Steam0020 ¹
Plant Repairs0026
Light, Power, and Water0034
Plant Insurance0006
Taxes0019
Depreciation0065
Directors' Fees and Expenses0002
Other0003
Total operating costs		\$0.0476

¹ Charge made by service department for steam received from this department.

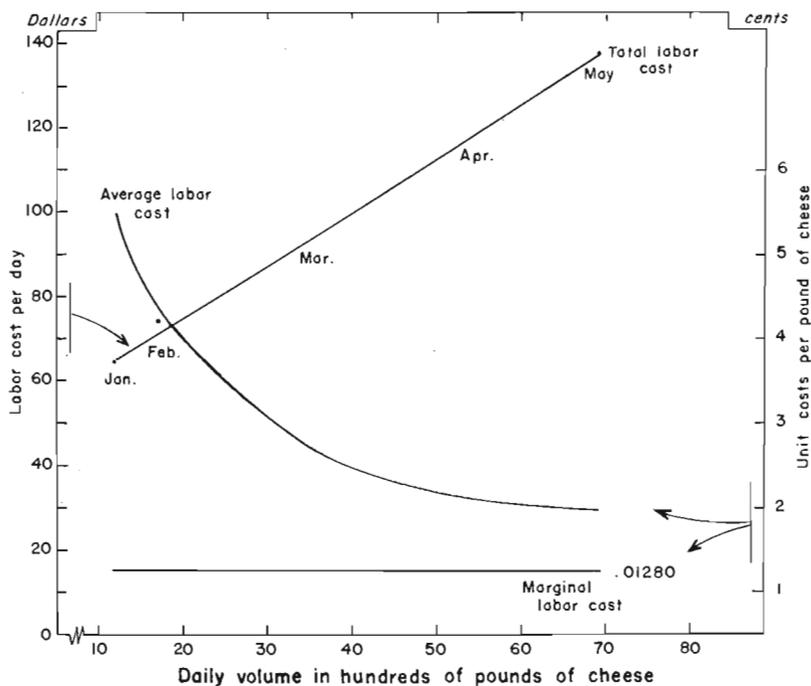


Figure 17. Total, average, and marginal labor costs for consolidated plant, 1950.

average unit labor costs in the consolidated plant varied with cheese output in a manner almost identical with that for Plant P, the most efficient of the older concerns. Marginal unit labor costs were constant throughout the entire range of operations, amounting to 1.28 cents per pound of cheese or the equivalent of about one man-day per thousand pounds of cheese. In other words a plant manager would be in a position to add one cheesemaker with each expected increase of 1,000 pounds output of cheese or to take off one cheesemaker for every decrease in output of 1,000 pounds.

During this early period of operation, the consolidated plant barely exceeded the maximum output of Plant P and operated considerably below maximum capacity. It is anticipated that increases in labor productivity will be experienced in the next few years. In addition, it should be noted that the consolidated plant was constructed as a multi-product operation to manufacture a number of by-products in addition to cheese. It would seem that building flexibility into the consolidated plant could result in higher unit fixed costs and possibly some increase in unit variable costs.

Supply costs were relatively low in comparison to other plants. Steam costs are charged to the service department supplying steam for the cheese plant. Noticeable increases in unit costs were for light, power, water, and depreciation. The first increase, to a large extent, is in air conditioning of the processing rooms. Depreciation charges increased because of a larger fixed investment per pound of cheese due to additional equipment, and a more costly type of building construction. These increases in cost would be expected to increase unit costs. There is substantial evidence that the total unit costs of cheese were reduced and further decreases are anticipated with increasing volume.

These economies due to increases in scale must be compared with the effects of transportation costs attributable to consolidation. The transportation costs before consolidation included assembly of milk from farm to plant; assembly of supplies from a central warehouse to the plant; and transportation of cheese, whey, and cream to a central point for storage, further processing or distribution. Under the consolidated plant, all transportation is eliminated except for milk. As the processing of cheese, whey and butter is carried on at the same place as storage and distribution facilities, milk must be transported further for Plants D, H, J, N, O, and P. It has been estimated on the basis of the average plant receipts of 1941-48 additional annual milk assembly costs of \$8,865.00 would be incurred—but an annual estimated saving of \$23,372.00 would be effected by the elimination of the hauling of cheese, whey, cream, and supplies.

This is equivalent to approximately 3 cents per hundredweight of milk received for the six plants. It has been the normal practice to assume that assembly costs would increase with consolidation which is logical when the milk assembly costs alone are considered. However, when considering costs of assembling cheese, by-products, and distribution of supplies, which are associated with a form of organization, it is possible that transportation costs will decrease upon consolidation of plants as indicated by this Association.¹

Summary

Two methods were used to determine the relationship of unit costs to volume. One involved a study of costs as they were reported for the 16 plants over an 8 year period 1941-48. The other developed, after certain adjustments were made, cost rates and variable costs for five of the 16 plants. The adjustments were made to eliminate certain variations existing in cost among the plants studied which were not necessarily related to differences in size.

An analysis of the 16 plants showed that unit labor costs decreased as much as 24 per cent with increases in average plant volume. Inclusion of fuel costs which normally decrease per unit of product with an increase in the size of the plant, probably accounted for the large part of the tendency of supply costs to decline as the volume of the plant increased. Unit costs for repairs tended to decrease with the size of the plant. The variations in charges for plant repairs were largely accounted for by differences in standards of maintenance of buildings and equipment. There appeared to be diseconomies in scale of operation in power costs which include water and electricity. This may be due primarily to different uses of power in the plants. Unit costs of taxes, insurance and depreciation decreased with increasing size of the plant. Total unit costs tended to decrease with increases in the size of the plant.

Adjusted total unit costs for manufacturing cheese in the five plants varied from 4.34 to 6.25 cents per pound. It may be concluded that there are economies of scale in the operation of cheese plants, but the minimum point on the long run planning curve of manufacturing costs appeared to lie beyond the range of volumes for the plants included in the study.

¹The estimates of the increased cost were based on budgeted costs for a normal milk assembly system with trucks hauling an average of 80 per cent of capacity. The savings effected were calculated from the actual rates being charged by the Traffic Department of the Association. It may be possible that some of these savings are due to increases in efficiency of transportation. Further studies of the effect of number and size of plant on transportation costs are under way in the West.

An analysis of the consolidated plant showed that average labor costs declined with every increase in plant capacity. Supply costs were relatively low in comparison to other plants. Noticeable increases in unit costs were for light, water and depreciation. There is substantial evidence that the total unit costs were lower in the consolidated plant.