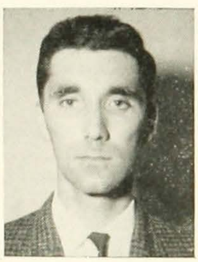
NO. 512. NOVEMBER 1968 AGRICULTURAL EXTENSION SERVICE UNIVERSITY OF MINNESOTA

Minnesota AGRICULTURAL ECONOMIST

Manufacturing Costs for Cheddar Cheese

N. B. Lilwall and J. W. Hammond



Technological changes in cheddar cheese manufacturing have put economic pressure on the many small cheese factories that traditionally have produced a large proportion of U.S. cheese. Low volume cheese factories have found themselves unable to compete with their large-scale neighbors, whose large capacity equipment offers significant cost savings. Their problems have been compounded by the difficulty of finding acceptable whey disposal methods. Economies of scale in this phase of the operation appear to be particularly important.

This study examined the relationship between cheese processing costs and operational size. Four distinct technologies were considered, and each was applied to three basic vat sizes. Hypothetical plants were constructed using current costs for buildings, equipment, labor, power, and supplies. This synthetic approach has the distinct advantage of complete comparability. Since we were concerned with minimum cost figures, all plants were assumed to operate on a three shift, 7 days per week basis during the peak period. Plants operating below full capacity during this period were not considered. Therefore, all plants discussed here are described in terms of their peak capacity. Costs given are annual average costs per hundredweight (cwt.).

Table 1. Cheese processing costs associated with three standard vat sizes and four different plant sizes

Vat size	Plant size in thousand pounds of milk per day at peak capacity			
	100	200	600	1,200
pounds	--cents per 100 pounds milk--			
15,000 . .	64.0	52.4	44.0	41.8
20,000 . .	62.8	51.7	43.2	40.8
25,000 . .	62.2	51.2	42.5	40.4

Each plant was designed to produce 40-pound block cheddar cheese. Whey cream could be churned into butter in the plant, but the whey itself could only be condensed and shipped out to be processed elsewhere.

Additional factors, such as shorter work weeks, shorter working days, overtime wages, and under-utilization of capacity, are not considered here. These variations are likely to be encountered in actual plant operation and will be analyzed in a forthcoming University of Minnesota bulletin.

Vat Size and Plant Size

As with most other production activities, ouput rate can be altered by changing the size of equipment or by duplicating equipment. For cheese plants, altering the vat size has some impact on labor costs, since many of the initial operations are on a per vat basis. However, the most significant economies occur when the number of vats is increased and total plant volume is raised. These economies occur because utilization of some areas and items of equipment is increased as plant size increases. There also may be some economies in the more specialized use of labor and management and in the more efficient use of power and utilities.

The effect of varying both cheese vat size and increasing output through expanding facilities is illustrated in table 1.

The economies gained through increasing plant capacity clearly overshadow

(Continued on page 3)

The Expanding Cheese Industry

Jerome W. Hammond

Though hundreds of foreign varieties of cheese are available to the U.S. consumer, most of our cheese consumption is from domestically produced varieties. This article describes some factors that point to continuing expansion in this industry.

Cheese: A Bright Spot

Expanding per capita consumption of cheese is a bright spot in the generally dismal dairy consumption picture. Per capita consumption increased from 7.7 pounds in 1950 to 10.0 pounds in 1967, a 29.8 percent increase (table 1). Together with our population growth, this increase has expanded the market by 65 percent between 1950 and 1969.

Expanding cheese consumption is not confined only to the United States. The Food and Agriculture Organization of the United Nations has compiled statistics on cheese consumption in 17 developed countries. For the period 1954 through 1962, each one of these countries experienced an increase in per capita cheese consumption.

Increases in cheese consumption are reflected in total use of market milk. In 1950, 11.7 percent of our total market milk supply was used in cheese production; by 1967, this percentage was 14.9. Because of rising per capita consumption and population trends and because total milk supplies show little indication of increasing, the percentage of milk in this use will continue to rise.

Location of Production

Cheese production is heavily concentrated in the east north central region of the United States, which annually accounts for more than 50 percent of total production (table 2). The leading states, in order of importance, have been Wisconsin, New York, and Missouri, with Minnesota and Kentucky exchanging fourth position. Wisconsin, located in the east north central region, produced 829 million pounds of cheese in 1967, about 43 percent of the U.S. total. In absolute production terms, Wisconsin has shown a steady increase, but its share of U.S. production has been relatively constant since 1945.

Trends in regional cheese production point to a shift in the geographic production pattern. The west north central

(Continued on page 2)

Expanding industry . . . cont'd from page 1

Table 1. Per capita U. S. cheese consumption, 1950-67 (includes whole and part skimmilk cheese, excludes cottage cheese)

Year	American pounds	Other pounds	Total
1950	5.5	2.2	7.7
1951-55 . .	5.3	2.5	7.8
1956-60 . .	5.3	2.7	8.0
1961-65 . .	6.0	3.1	9.1
1966	6.2	3.6	9.8
1967	6.4	3.6	10.0

"Dairy Situation," May 1968

region (Minnesota, Iowa, Missouri, South Dakota, North Dakota, Nebraska, and Kansas) is accounting for an increasing share of total U.S. cheese production (table 2). This region accounted for 11.3 percent of U.S. production in 1945 and 21.7 percent in 1967. Part of the reason for this high percentage is that large quantities of manufacturing grade milk are available here. Expanding demand for cheese relative to butter and nonfat dry milk has shifted milk into cheese rather than the latter. Also, fewer large fluid milk markets, which take priority claim on milk supplies, are located here than in the east north central region. Minnesota, with only 1.9 percent of U.S. cheese production in 1945, accounted for 5.2 percent in 1967. Between 1960 and 1967, North Dakota increased its cheese production from 842,000 pounds to 27 million pounds. South Dakota and Nebraska have shown large increases. Consequently, the west north central region expanded its cheese production by 229 percent from 1945 to 1967, compared to only 45 percent for the east north-central region. There appears to be a shift in the cheese area from east to west in the north-central region.

Cheese: Domestic and Imported

By far the most important cheese produced and used in the United States is American cheese. It is consumed principally as natural aged cheese or in processed cheese products. In recent years, large quantities have been used in prepared, ready-to-cook food products. It comprises almost two-thirds of U.S. per capita cheese consumption. Most of it is produced domestically.

Imports make up a small share of total domestic cheese consumption. But imports are the only source of many minor types. Except in 1966 and 1967, imports accounted for about 4 percent of total cheese consumption. With greatly expanded Colby imports in those years, imports rose to 8 percent of domestic cheese use in 1967. Swiss and Pecorino were the two largest imported types. Import quotas wil cut off most Colby imports in 1968.

Cheese Consumption Levels

Numerous factors are associated with the level of cheese consumption: Changes in income, price changes, and changes in personal tastes and preferences are some of them. Advertising and promotion, education, social status, and new living habits also shape tastes and preferences.

The data in table 3 indicate what happens to per family cheese consumption as income increases. For urban areas, cheese consumption increases from .41 pound per week for families with less than $3,000 annual income to .89 pound for families with annual incomes in excess of $10,000. Consumption increases consistently, with the same pattern visible throughout the income ranges. Actual response of cheese consumption to income has been measured in various studies. One study using 1955-57 data estimated that for each 1 percent increase in income, cheese consumption

Table 3. Cheese consumption in U.S. households, 1965

Income level (dollars)	Consumption per family: All urbanization	Urban	Rural nonfarm	Rural farm
	---pounds per week---			
Under 3,000	.41	.37	.44	.56
3,000-4,999	.58	.55	.65	.62
5,000-6,999	.77	.76	.81	.86
7,000-9,999	.84	.81	.96	.89
10,000 and over . .	.89	.89	.92	.86
All	.66	.67	.71	.70

Source: "Food Consumption in Households in the U.S.," Spring 1965, USDA, Aug. 1967.

increased almost ½ percent.[1] At first glance, then, increasing income appears to be a major factor in increasing cheese consumption in the United States. However, the data do not show important differences in consumption because of urbanization differences.

The price of cheese also affects consumption, but in the opposite direction as income. It is estimated that cheese consumption decreases by .7 percent for each 1 percent increase in price.[2] This decrease is large relative to the income effect; therefore, changing tastes and preferences must be important in the net change in cheese consumption.

Other factors affecting cheese consumption are difficult to measure though they obviously have been important. They include promotional and merchandising programs, the wide variety of precut and packaged cheeses now available, and the existence of specialty cheese shops in most metropolitan markets. State governments, the American Dairy Association, and private companies have invested a large number of resources in cheese promotion.

The versatility of cheese also contributes to its wide acceptance. It is served as an appetizer, as a snack, or as a main part of the meal, and it is widely used as an ingredient in other foods.

Moreover, consumer awareness of the nutritional value of cheese probably has contributed to increased consumption. Few foods provide such high quality protein.

Conclusions

We can therefore draw these conclusions about the U.S. cheese consumption picture: (1) The share of domestic U.S. milk production used in cheese will continue to rise. (2) The geographic location of cheese manufacture will continue to shift, primarily to the west of the existing area. (3) Increasing per capita cheese consumption will partially offset the continuing consumption decline of other dairy products. ■

Table 2. Total cheese production, excluding full skim American and cottage cheese, United States*

	1945		1950		1955		1960		1967		
	Million pounds	Percentage of U.S. Total	Million pounds	Percentage of U.S. Total	Million pounds	Percentage of U.S. Total	Million pounds	Percentage of U.S. Total	Million pounds	Percentage of U.S. Total	Percentage Change 1945-1967
New England and Middle Atlantic	82	7	110	9	130	10	149	10	185	10	+125
East north central . . .	706	63	748	63	802	59	830	56	1,022	53	+ 45
West north central . . .	126	11	140	12	207	15	236	16	416	22	+229
South Atlantic and south central	111	10	112	9	137	10	163	11	171	9	+ 54
Mountain and Pacific. .	92	8	82	7	86	6	100	7	119	6	+ 40
United States	1,117	100	1,192	100	1,363	100	1,478	100	1,913	100	+ 71

Source: "Production of Manufactured Dairy Products," Annual Summaries, SRS, USDA

* All figures have been rounded to the nearest whole number.

[1] Brandow, G., *Interrelations Among Demands for Farm Products*

[2] Ibid.

Costs . . . cont'd from page 1

the gains associated with increasing vat size. But not all plants can command increased milk supplies. For those that cannot, using larger vats can be important. Smaller plants can save 1.8 cents per 100 pounds of milk processed by installing vats with 25,000 pounds capacity instead of 15,000 pounds. Unfortunately, the 25,000 pound vat is about the largest that permits men to work the curd over the side. Larger vats require special cheddaring tables.

Cheddaring Tables

With cheddaring tables, the last half of the 6-hour process is done outside the cooking vat. This change allows the cooking vat size to be increased beyond the 25,000 pound capacity, which yields a small net gain.

A further advantage is that, by dividing the cheesemaking process into two parts, the turnover rate in each part is increased. So, if six vats were required in the old system, three cooking vats and three cheddaring tables can be used in the new. To mechanize the transfer of curd to the hoops, only the three cheddaring tables would have to be modified, compared with six vats in the old system. As a direct consequence, introducing another labor saving device — the automatic weigher and hooper — becomes economical. This equipment reduces the total labor requirement and saves a further 0.4 cent in the smaller plants and just over 1 cent per 100 pounds processed in the larger plants.

The automatic miller, salter, weigher, and hooper showed a marginal saving over the smaller automatic weigher and hooper in plants handling more than 500,000 pounds of milk daily at the peak. The saving was consistent (0.1 cent per 100 pounds) beyond this capacity and is illustrated in table 2.

In practice, plant managers usually are faced with the problem of finding the best technology associated with a given milk supply, while the industry as a whole may be able to consider the implications of different supply levels when planning for new plants. The accompanying figure can be useful in finding answers to both problems.

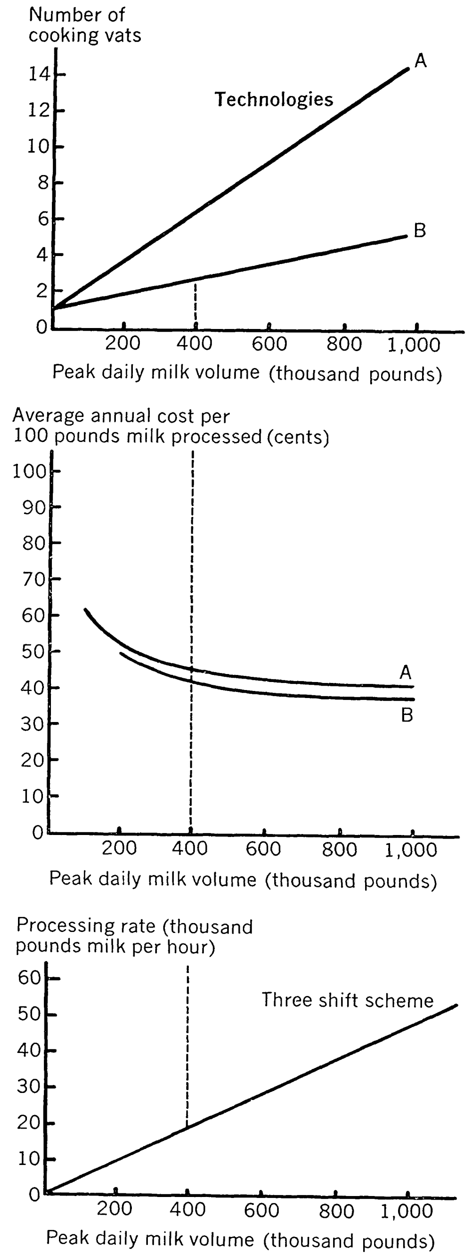
Consider a manager who receives 400,000 pounds of milk per day at the peak. The middle diagram indicates that his lowest cost technology is B and that his processing cost will be 42.7 cents per cwt. of whole milk. Moving up from this point to curve B on the upper diagram, we see that this volume would require three of the 30,000 pound vats associated with technology B. Following the dotted line down to the lower diagram, we see that our three shift assumption requires that the milk (and whey) be processed at a rate of 20,000 pounds per hour. This information is needed to determine how large the separation, pasteurization, and evaporation equipment should be.

For a firm deciding on the capacity for a new plant, the middle diagram indicates the most efficient technology and also the potential savings associated with incremental rises in the total volume handled. Presumably there is a trade-off between economies to scale and the cost of hauling milk from greater distances. Once plant size has been determined in this way, the vat numbers and the size of the other processing equipment needed can be found from the diagram, as indicated in the previous example.

The above system assumes a three shift, 7 days per week operation. Changes in these specifications would yield different costs and would require a new set of cost curves.

Conclusion

This study emphasizes, once again, the overriding pressure in the dairy processing industry for larger plants. Gains can be made by introducing more efficient and more up-to-date equipment, but an extra supply of 50,000 pounds of milk per day can do more for a small plant than all technological advances put together. ■



Technologies

A = 20,000 pound cooking vats only

B = 30,000 pound cooking vats with cheddaring tables and automatic milling, salting, weighing, and hooping equipment

Table 2. Cheese processing costs associated with four technologies and six plant sizes

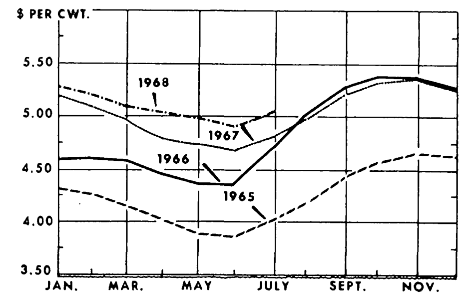
	Plant size in thousand pounds at peak daily capacity					
Technology	200	300	400	500	600	1,200
	---------cents per 100 pounds milk---------					
25,000 pound standard vats	51.2	47.1	44.8	43.6	42.5	40.4
30,000 pound cooking vats with cheddaring tables	50.0	46.2	43.6	42.0	40.9	38.7
30,000 pound cooking vats with cheddaring tables and automatic weighing and hooping	49.6	45.0	42.4	40.8	39.8	37.6
30,000 pound cooking vats with cheddaring tables and automatic milling, salting, weighing, and hooping	49.7	45.5	42.7	40.9	39.7	37.5

NEW PUBLICATION EXAMINES IMPORT QUOTAS

The Protectionist Mood and Midwest Agricultural Trade. James P. Houck and James G. Kendrick. Ext. Bull. 355 (N. C. Reg. Ext. Pub. 24) Univ. of Minn. Agri. Ext. Serv. Oct. 1968.

This recently published bulletin describes and analyzes free trade and protectionism and their effects on U.S. agriculture, particularly Midwest agriculture. For a copy, write: Bulletin Room, Institute of Agriculture, University of Minnesota, St. Paul, Minnesota 55101.

IN PERSPECTIVE



Monthly U.S. milk prices (Source: "The Dairy Situation," Sept. 1968)

Some Aspects of Average Milk Prices

Jerome W. Hammond

Reported prices for milk represent an average of prices for all uses and all regions of the United States. Beginning in 1965, the average U.S. price for milk began to rise and surpassed its previous high of 1948. The reason for the increase is a combination of (1) commercial demand and supply relationships and (2) government activities under the price support program and the federal order program.

The average U.S. price received by farmers generally is not the price received by any one group of farmers. For example, prices under state and federal order programs are established according to the use made of the milk. Handlers pay a high price for milk for fluid uses and a lower price for manufacturing uses (butter, dry milk, cheese, etc.) (see the table). For most of 1957-67, the lower price was roughly the support price established by the federal government. The two prices for 1967 were $6.18 per hundredweight (cwt.) for fluid milk and $3.91 for manufacturing milk. Producers who sell into markets where milk is used for both purposes receive a blend price, $4.86 in 1967, based on the amount of milk in each of the uses and the respective use prices. Thus, higher prices will occur as the percentage of milk in fluid use increases.

The difference between fluid and manufacturing milk prices is determined largely through administrative procedures and the bargaining efforts of cooperatives that control the supplies of fluid eligible milk. The data in the table indicate a differential of about $2.40 per cwt. for 1957-60 and then falling through 1966. Since 1967, these differentials have risen back to the $2.40 level.

Geographic differences in milk prices are very prominent. The lowest average price received for all milk in 1967 was $4.27 per cwt in the west north central states. The highest average price, $6.22 per cwt., was received in the south Atlantic states. Prices in all other regions fell within this range. The differences occur because of both different prices for fluid use milk in each area and because of differing proportions of fluid milk uses in each of the regions. Fluid use prices in 1967 ranged from a low of $5.45 in the west north central states to $6.78 in the New England states.

Average prices and differentials for milk in the United States, 1957-68

Year and month	Dealer's buying price for fluid use	Manufacturing grade milk	All milk	Fluid above manufacturing grade
	dollars per cwt. (3.5% butterfat milk)			
1960	5.48	3.07	4.04	2.41
1961	5.43	3.18	4.06	2.25
1962	5.35	3.04	3.95	2.31
1963	5.31	3.06	3.98	2.25
1964	5.35	3.13	4.03	2.22
1965	5.39	3.21	4.09	2.18
1966	5.82	2.82	4.65	2.00
1967	6.18	3.91	4.86	2.27
1968				
Jan.	6.33	3.93	5.03	2.40
Feb.	6.33	3.91	5.01	2.42
Mar.	6.33	3.93	4.95	2.40
Apr.	6.33	4.09	4.90	2.24
May	6.48	4.10	4.93	2.38
June	6.50	4.09	4.88	2.41
July	6.54	4.09	5.01	2.45
Aug.	6.55	4.10		2.45

Source: "The Dairy Situation," Sept. 1968

The seasonality of milk prices is indicated in the figure. However, the data on use prices indicate little seasonality. For most periods, manufacturing milk prices are near the support level, which is not adjusted seasonally. Some, but relatively little, seasonality exists in prices for fluid use milk. Yet marked seasonality occurs in the average price for all milk. This seasonality results almost entirely from changes in quantities of milk in each use. For example, April, May, and June are months of high milk production. Fluid consumption exhibits a relatively constant level throughout the year. So a smaller proportion of the total milk supply goes for higher price fluid uses. The resulting average price falls. In the fall months, September, October, and November, the opposite situation prevails. The average price is relatively high during these months (see the figure).

The foregoing illustrates that average prices for all milk are an aggregate measure. The prices may indicate the direction of change, but they seldom represent actual prices recorded by farmers. ■

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Roland H. Abraham, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55101.

Minnesota AGRICULTURAL ECONOMIST

Prepared by the Department of Agricultural Economics and the Agricultural Extension Service.

Published by the University of Minnesota, Agricultural Extension Service, Institute of Agriculture, St. Paul, Minnesota 55101.

Agricultural Extension Service
Institute of Agriculture
University of Minnesota
St. Paul, Minnesota 55101

Roland H. Abraham, Director

Cooperative Agricultural Extension Work
Acts of May 8 and June 30, 1914

OFFICIAL BUSINESS

10-68 3,085

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF
AGRICULTURE