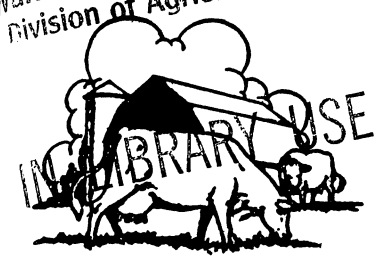

MINNESOTA
farm business NOTES

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Economies of Size in Dairy Farming

Boyd M. Buxton*

For the past decade the number of dairy herds with more than 30 cows has increased rapidly in Minnesota while farms with fewer than 20 cows have decreased.

New dairy housing and milking systems have been, and will continue to be, important factors in this shift. Because of their lower labor requirements, new housing and milking systems have allowed many farmers to expand herd size. However, high investment costs are associated with these new technologies.

These changes raise several questions for the dairy industry:

Can farmers with larger herds but higher investments produce milk at lower cost than farmers with typical small dairy units?

How do costs change as farmers shift to larger dairy herds using the new laborsaving systems?

How will the size of dairy herds change in the future?

Methods

In considering these questions, five one-man and one two-man dairy housing and milking arrangements were studied.

The one-man systems included two stanchion barn and three herringbone parlor systems; the two-man system was a double-8 herringbone parlor. On the basis of engineering, labor, cost, and other data, budgets for each housing and milking arrangement were constructed to represent the actual dairy systems.

Production from the dairy farms was measured in dollars of gross income. The study's objective was to determine the lowest cost method of generating several levels of gross income from each dairy system. Knowing the minimum cost and gross income, returns to the operator and average cost per dollar of gross income could be calculated for dairy herds up to 90 cows.

Any one dairy system was not the lowest cost for all sizes of dairy herds, but it was the lowest cost for a range of herd sizes. Results estimate how costs change as herd size expands in each of the six dairy systems.

Basic Assumptions

Several assumptions made in the study that had important effects on results were:

1. All buildings were built from scratch and were planned to exact specifications of the dairy herd. However, the milking parlor remained the same size regardless of the number of cows milked.

2. Crop yields and production costs were determined for southeastern Minnesota. Nevertheless, the results should have application in other areas.

3. All replacement stock were raised on the farm. Cows producing 12,000 pounds of milk annually were held in the milking herd for an average of 4 years.

4. Most machinery, buildings, milking stalls, and equipment were assumed to have a life of only 15 years because of possible obsolescence. In this period of rapid technological change, a system should be able to pay back resources within a 15-year period.

5. "Dairy farm," as used here, refers to a farm organization in which at least 60 percent of total gross income was generated by the dairy enterprise in the form of milk receipts and sale of calves and cull cows. The remaining gross income (up to 40 percent of the total) could have been generated by one or more of three alternative enterprises: sale of hogs, corn, and soybeans. Except when labor was limiting, corn was the cheapest way to supplement gross income.

Available Resources

Machinery—Three groups of field machinery were considered. Size of individual items of machinery for each group was selected on the basis of tractor size. The 3-plow machine group was used as long as labor was not limiting. The 4- and 5-plow machine groups were used to decrease field labor and enable the dairy farmers to increase herd size and gross income.

Labor and Management—Initial adjustments were made in the labor supply to provide for such fixed labor requirements as building and equipment maintenance, buying and selling, and other miscellaneous jobs. The remaining labor could be used directly in crop and livestock enterprises. The operator could not work more than 300 hours in any 1 month nor more than 2,500 hours in 1 year.

The two-man system had one full-time hired man in addition to the operator's labor.

Because of seasonal labor peaks, allowance was made for hiring seasonal labor in amounts up to 50 percent of the full-time labor available.

If full-time or seasonal labor was hired, the operator's labor supply was reduced to provide for his additional management functions.

Capital and Land—Land and capital were considered available in unlimited quantities. Land could be purchased at market prices to meet exact requirements of the dairy herd. Sufficient capital was available to purchase all resources for the dairy farm.

Stanchion Barn and Herringbone Systems

The two stanchion systems considered were a three-milker unit with pipelines and a two-milker unit carry system. Both arrangements had bulk tanks. The stanchion systems were

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automated with gutter cleaners, silo unloaders, and other laborsaving equipment.

The stanchion barn was large enough to house all milking and dry cows in stanchions. Heifers from 12 to 28 months of age were housed separately, but pens were provided in the barn for all replacement stock up to 12 months of age.

Four herringbone milking parlors were considered in this study. Three were one-man systems: the double-4, double-5, and double-6 stall arrangements. The double-8 herringbone was a two-man system.

Parlors were equipped with automatic grain feeding systems, glass pipelines, and bulk tanks of sufficient size to adequately meet production of the dairy herd.

The herringbone systems were automated with silo unloaders, automatic feeders, and other laborsaving equipment.

The Dairy Ration

The dairy herd was fed in drylot the entire year. This is a common practice as herds get too large for convenient pasturing.

At least 50 percent of the roughage requirement (on a dry matter basis) had to come from corn silage and at least 10 percent from alfalfa hay.[1] The remaining roughage requirement came from either corn silage and protein supplement or from alfalfa hay, depending on which source provided it at the lowest cost. In all systems considered, alfalfa hay was the cheapest source and supplied the 40 percent balance of the roughage requirement.

All feed supplies were raised on the farm; however, 20 percent of the feed grain requirements could be purchased.

Input-Output Requirements

Labor requirements were estimated for each milking arrangement by dividing all work into specific chore tasks. Time for each chore was estimated. Then these estimates were added in order to obtain total labor requirements for handling and milking dairy cows.

Labor requirements for cropping enterprises were estimated individually for each of the three machinery groups.

Budgets were constructed for all farm enterprises. Therefore, all costs and returns associated with the various crop and livestock enterprises were estimated. Major product prices used for this phase of the study are listed in table 1.

Table 1. Projected 1968 prices used in study

Product	Unit	Price
Milk	cwt.	$ 3.65*
Hogs	cwt.	15.10
Corn grain	bu.	1.01
Soybeans	bu.	2.19

* Grade A fluid-eligible price.

Analysis and Results

The figure presents the average total cost per dollar of gross income for each of the six dairy systems. Average cost for each system decreased at first as the amount of gross income generated increased.

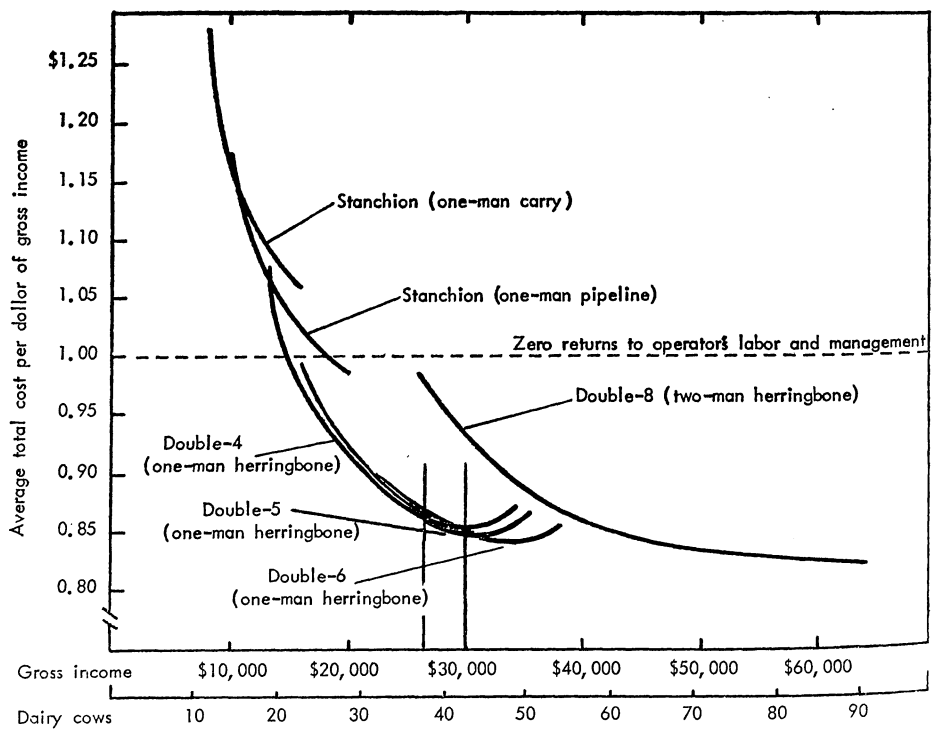
Results presented in the figure also show that the gross income from the stanchion barn (with the two bucket units in which milk is carried to the bulk tank) did not cover total costs. The maximum gross income one man generated, using the 3-plow machine group, was about $16,000. Total costs were $16,838, resulting in a net loss of $838.

Labor requirements were relatively high in this system; labor became restrictive at such a low level of gross income that the fixed costs (mainly machinery and dairy facilities) were still a relatively large proportion of total costs. Spreading the fixed costs over a relatively small gross income resulted in high average costs and negative returns to the operator.

The stanchion barn with the pipeline systems and three-milking units had lower labor requirements than the above stanchion barn. Here the average cost was relatively high at first and decreased sharply as higher levels of gross income were produced (see figure). Again, however, labor became restrictive at a relatively low gross income, leaving average costs quite high.

The maximum gross this technology generated with the 3-plow machinery group was $20,000. The average cost fell below $1 cost per dollar of gross income only between $18,000 and $20,000 of gross income. At these high levels of gross income, small returns to labor and management were obtained.

Looking at the herringbone parlors with lower labor requirements, one man was able to handle more dairy cows and, thereby, increase the attainable level of gross income. Lowest costs per dollar of gross income were achieved using the 3-plow machine group. Increasing income by employing 4- and 5-plow machinery groups increased the average cost; the larger machinery could not be used on enough acreage to adequately reduce unit costs. This can be observed in the figure where the average cost curve turns up.



Average total cost curves for two stanchion and four herringbone milking arrangements.

[1] Three pounds of silage equals 1 pound of hay on a dry matter basis. The silage has less digestible protein.

Lowest average costs for the double-4, 5, and 6 occurred at the $30,000 (44 cows), $32,000 (46 cows), and $34,000 (48 cows) levels of gross income, respectively. Average costs for all three systems increased when higher levels of gross income were generated using the 4- and 5-plow machinery groups. The average cost curves for all herringbone systems were extended to the maximum gross income that can be generated using the largest or 5-plow machinery group.

Average costs were almost the same for each of the three one-man herringbone systems. However, slightly higher levels of gross income could be generated with the largest parlors due to their lower labor requirements.

The double-8 herringbone was a two-man operation. The average cost curve for this system, illustrated in the figure, decreased as the level of gross income generated increased. Average cost was substantially higher than for the double-4, 5, and 6 herringbone parlors for herd sizes ranging from 37 to 52 cows. These sizes could generate levels of gross income between $26,000 and $37,000—the maximum gross from the one-man system.

However, costs continued to decline; beyond $50,000 of gross income average costs were lower for the two-man system. The maximum gross income the two-man system generated under the assumptions listed was $64,000.

Returns to the operator and management were substantially higher for the two-man system because of the larger volume of output. Investments and returns to the operator's labor and management for these "least-cost" dairy farms are presented in table 2. Each system was the lowest cost system for a range of dairy herd sizes.

Table 2. Least-cost dairy systems for specified levels of gross income

Milking arrangements	Number of men milking	Total acres	Number of cows in herd	Gross income*	Total annual cost	Returns to operator	Investment				
							Land	Machinery	Dairy (building and equipment)	Dairy cows and replacements	Total
				dollars							
Stanchion:											
Carry	1	61	11	8,000	10,231	—2,231	18,400	31,100	8,200	4,200	61,900
Pipeline	1	77	14	10,000	11,692	—1,692	23,000	31,100	10,000	5,300	69,400
Herringbone:											
Double-4	1	107	20	14,000	14,437	— 437	32,200	31,100	17,200	7,300	87,800
Double-4	1	138	26	18,000	16,888	1,112	41,400	31,100	19,100	9,400	101,000
Double-4	1	169	31	22,000	19,436	2,564	50,600	31,100	20,900	11,500	114,100
Double-4	1	199	37	26,000	22,422	3,578	59,800	31,100	22,700	13,600	127,200
Double-5	1	199	37	26,000	22,418	3,582	59,800	31,100	23,700	13,600	128,200
Double-5	1	230	44	30,000	25,367	4,633	69,000	31,100	25,500	15,700	141,300
Double-5	1	267	46	32,000	27,141	4,859	80,100	31,100	26,400	16,800	154,400
Double-6	1	289	48	34,000	28,459	5,541	86,600	31,100	28,600	17,800	164,100
Double-6	1	296	49	34,500	28,928	5,572	88,700	31,100	28,700	18,100	166,600
Double-6	1	280	50	35,000	29,656	5,344	83,900	40,000	27,300	18,400	169,600
Double-6	1	276	51	36,000	30,916	5,084	82,800	48,100	29,500	18,900	179,300
Double-6	1	288	52	37,000	31,668	5,332	86,500	48,100	30,000	19,400	184,000
Double-8	2	322	60	42,000	35,965	6,035	96,600	31,100	33,600	22,000	183,300
Double-8	2	383	71	50,000	41,804	8,196	115,000	31,100	37,300	26,200	209,600
Double-8	2	452	82	58,000	47,792	10,208	135,700	31,100	41,000	30,400	238,200
Double-8	2	497	85	60,000	49,430	10,570	149,200	31,100	41,900	31,500	253,700
Double-8	2	489	87	62,000	51,081	10,919	146,600	40,000	42,800	32,500	261,900
Double-8	2	491	91	64,000	52,813	11,187	147,200	48,100	43,700	33,600	272,600

* Forty percent of gross income is from sale of corn for grain.

Implications of the Study

Longrun planning considerations, such as those reported here, are of primary importance for persons "getting started" in dairying or building a new dairy system. The dairy with the lowest average cost will, over time, be in the best competitive position.

On the basis of this longrun planning, returns to labor ranged from a loss of over $2,000 with a one-man stanchion system to net returns of over $11,000 with the two-man system. The maximum return of $5,572 to the operator of a one-man dairy farm occurred with a double-6 herringbone system, generating $34,500 of gross income.

Of the highly mechanized dairy farms considered in this study, the stanchion barn systems were the least-cost methods of producing gross income up to about $13,000. However, at this level of gross income, total costs remained higher than gross income and losses were incurred.

This does not mean that all stanchion systems are now losing money. However, costs of these relatively automated systems remain high when all resources are being paid for from current income and when labor supply limits the number of dairy cows.

Between $13,000 (18 cows) and $26,000 (37 cows) of gross income, the double-4 herringbone was the least-cost technology. The double-5 and 6 herringbone parlors with 1-man year of labor were the least-cost systems from $26,000 (37 cows) to $30,000 (44 cows) and from $30,000 to $37,000 (52 cows), respectively.

For gross incomes larger than $37,000 or operator earnings greater than $5,572, employment of a second man was necessary. The double-8 herringbone was the least-cost technology for levels of gross income between $37,000 (52 cows) and $64,000 (91 cows).

Investment in the entire dairy farm ranged from $61,900 for the stanchion (carry milk) with 11 cows to $272,600 for the double-8 herringbone with 91 cows. About 55 percent of total investment was in land and about 20 percent in dairy buildings and equipment. Investment in field machinery was either $31,100, $40,000, or $48,100—depending on the size of the machinery complement used.

These systems included a relatively high level of automation under the assumption that farms will move towards more automation in the future. In the current price-cost squeeze felt by farmers, the lowest-cost dairy farm will be in the best position. The margin between gross income and total costs represents income available for family living expenses and additional investment in the farm business.

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the outlook corner

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For over a decade, prices received by dairymen have been supported through government purchases of butter, cheese, and nonfat dry milk. But what of the future?

Consumption Trends

Since the early 1930's, per person consumption of the fat component of milk has declined. This fact reflects the declining demand for butter and some other high fat products such as fluid cream. Consumption of milk fat was 23.3 pounds per person in 1963 compared to 32-33 pounds in the early 1930's.

Butter consumption per person in 1963 was 6.8 pounds, the lowest on record. This declining consumption was a continuation of a trend that began in the early 1930's. Although the decline in butter consumption was accelerated during World War II, it was offset by increased consumption of fluid milk and other dairy products.

Since that time butter consumption has been increasingly affected by competition from margarine. Other dairy products, such as fluid cream and ice cream, also have been subjected to increasing competition from lower priced vegetable fats.

Consumption per person of the nonfat solids component of milk increased from the early 1930's well into the 1040's. Since that time, consumption has remained fairly stable except for some small declines in recent years. Per capita consumption of high nonfat solids products such as American cheese, cottage cheese, and ice milk have shown consistent gains in recent years.

Production Trends

U.S. milk production increased from 109 billion pounds in 1940 to 126 billion pounds in the record year of 1962—an increase of about 15 percent over 22 years. At the same time, however, total butterfat production increased by only about 6 percent because of the lower average butterfat content of the milk produced.

Even though increases in butterfat production did not keep pace with increases in milk production, market supplies of fat increased considerably because of a declining farm use. Market supplies of fat increased by 31 percent between 1940 and 1962; the proportion of fat sold by farmers increased from 76.0 percent of that produced in 1940 to 93.8 percent in 1962.

Marketings of nonfat milk solids showed an even more pronounced change than did marketings of fat due to the shift from delivery of cream to delivery of whole milk to receiving plants. Market supplies of nonfat milk solids about doubled between 1940 and 1962 while the proportion of milk produced which farmers sold increased from 50.8 to 89.6 percent. During the same period, actual production of nonfat milk solids increased by 11 percent.

Government Purchases

Before 1949, comparatively small quantities of dairy products were acquired through price support purchases. In only 1 year during that period did purchases exceed the equivalent of 1 billion pounds of milk. Since 1949, however, purchases exceeded this figure every year except one. In 1953 and again in 1962, purchases mounted to an equivalent of over 10 billion pounds of milk. Since 1962 they have declined to about 7.7 billion pounds.

What's Ahead?

Changing technological conditions in milk production and distribution, as well as changing conditions of economic growth and performance, make it difficult to gage the future. Nevertheless, with the aid of some assumptions, projections of trends may be made that shed some light on possible future developments. These assumptions are:

- Technological developments in the dairy industry and growth in the entire economy will continue at about the present pace.
- Prices for most dairy products and substitutes will remain at about present levels.
- Current levels and methods of price support will continue.

Continued population growth will increase the demand for dairy products. However, the many forces which have caused a decline in per person consumption of milk fat will probably continue to operate in the future.

On the other hand, products with comparatively low fat content, such as nonfat dry milk and low fat fluid milk and ice cream, have a brighter outlook so that per capita consumption of these products is likely to expand. In addition, the expansion of cheese consumption will likely continue.

Milk production should continue to increase, even though the number of cows and dairy herds is declining. Increased production per cow in line with the 180-200 pound annual increase of the past 10 years will more than offset declining cow numbers. In addition, market supplies will increase because of the continued decline of milk used on farms for home use and livestock.

Comparison of future possible trends in consumption and production indicates that for a period of years the market supply of milk should exceed commercial demand. Therefore, price support purchases are likely to be required for some time. However, the trend in the quantity of price support purchases should edge downward because commercial demand probably will increase at a slightly more rapid rate than farm marketings.

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