Economic and Functional Characteristics of

FARM DAIRY BUILDINGS

By
R. N. Van Arsdall,
D. B. Ibach,
and
Thayer Cleaver

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Economic and Functional Characteristics of Farm Dairy Buildings

By R. N. Van Arsdall, D. B. Ibach, and Thayer Cleaver[1]

THE LARGE NUMBER OF OLD BUILDINGS still in good physical condition on Illinois farms emphasizes the construction and remodeling problems confronting their owners. Many buildings that were already out of date before World War II have been made even more inadequate by the rapid changes that have occurred in farm technology in recent years.

A question foremost in the mind of many farmers today is what they can do to modernize their present buildings and how they can plan new buildings for continued usefulness. So far as new buildings are concerned, the problem can be largely solved by following designs that will permit relatively easy adjustment to future uses and by building less costly structures that can be replaced when they no longer fit the farming need. Whether to remodel an old building will depend on whether it is structurally possible to do so and financially practicable.

Because of their fixed character and the effect which their design has in helping or hindering efficient production, farm buildings are of more importance, in comparison with other farm investments, than is indicated by their money value.

PURPOSE AND METHODS OF STUDY

The principal objectives of this study were:

1. To determine the total investment and cost of all farm service buildings on 350 Illinois dairy farms for which farm accounts were available.

2. To determine that portion of the investment and cost of all farm service buildings directly chargeable to the dairy enterprise.[2]

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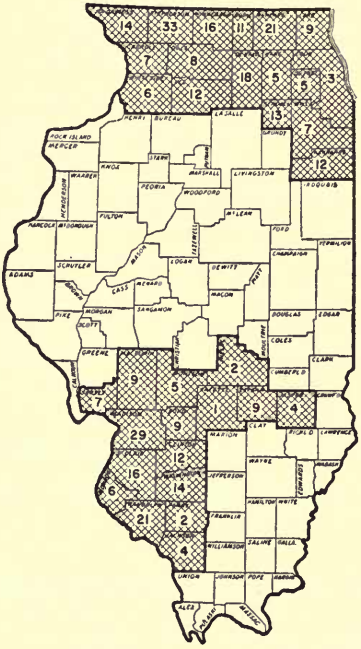
[1] R. N. Van Arsdall, Agricultural Economist, Bureau of Agricultural Economics, U. S. Department of Agriculture and the Illinois Agricultural Experiment Station; D. B. Ibach, Agricultural Economist, Bureau of Agricultural Economics, U. S. Department of Agriculture; Thayer Cleaver, Agricultural Engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

[2] In this bulletin the term "investment" is used to indicate the current inventory value of the resource involved unless otherwise stated.

3. To determine whether the returns from the dairy enterprise were sufficient to meet the costs of dairy buildings.

4. To determine the effect of facilities and layout of buildings and resulting management practices on returns from the dairy enterprise.

5. To analyze the relationships found between 1, 2, 3, and 4 above so as to increase the serviceability of dairy farm buildings and recommend economies in new construction and remodeling.



Counties in the Illinois portions of the Chicago and St. Louis milksheds where the 350 farms studied were located. Two hundred were in the northern section and 150 in the southern. (Fig. 1)

Two hundred farms in the Illinois portion of the Chicago milkshed and 150 in the Illinois portion of the St. Louis milkshed (Fig. 1) were selected for study in the summer of 1948. All the data concerning these farms, both physical and economic, apply to the year 1947. On all farms 10 or more cows were milked during 1947. For the economic analysis, data were taken from complete financial records kept by operators on 329 of the farms studied.[1]

[1] All of the 350 farms kept account books, but financial records were complete on only 329.

In that part of the study dealing with investment and cost,[1] all service buildings were included, but only the dairy buildings were given functional ratings. As no satisfactory scale was available for comparing the degree to which the different dairy buildings met the need of a dairy farm, one was developed. This was done by pooling the opinions of dairy, engineering, and farm-management specialists on what they considered desirable, in terms of layout, structure, and facilities for efficient operation. The resulting specifications were assigned proportions of the total score of 100, after being judged by the group for their importance in influencing (1) production, health, and safety of the cows; (2) labor efficiency and the safety of the operator; and (3) quality of milk.

The rating given each detail of the buildings examined was arrived at by comparing that detail with the standard established for it. For any given farm the sum of the scores given the separate characteristics represents the functional rating of the entire dairy building organization.

Some of the data taken from the farm records were essentially subjective, especially the inventory of real estate including buildings. Enough information was obtained on the dimensions, age, materials, structural level, and condition of the dairy buildings to permit their reappraisal by using unit-cost data at stated price levels.[2] This procedure in modified form was also applied to all service buildings.

Land valuations taken from the farm record books were adjusted to reflect variations in soil productivity. Unadjusted record-book inventory values were used for other farm and dairy investments. All data on investment, cost, and returns are presented in terms of 1947 price levels.

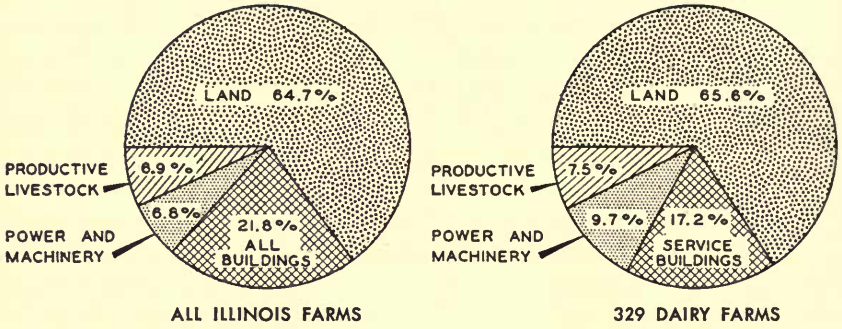
Statistical methods, including both multiple regression and variance analyses, were used whenever the data permitted.

CHARACTERISTICS OF THE FARMS STUDIED

In the Chicago area, 214 acres was the average size of the farms studied; in the St. Louis area, 230 acres. In both areas the farms may in general be classified as crop-dairy farms. On many farms hogs were

[1] As used in this study, "cost" is the sum of both cash and noncash charges whether for a single productive factor, an enterprise, or the complete farm business. When the term "cost" is used in any other sense it is qualified accordingly. Cash expenses are synonymous with cash costs.

[2] Unit cost refers to cost per cubic foot or square foot of construction. For definition of "structural level" see page 17.



Distribution of investments on all farms in Illinois as shown by 1940 census data is similar to that on the farms in this study. Dwellings are included in the data for all farms but not in the investments on the dairy farms. (Fig. 2)

an important source of income; and on a few farms, beef cattle and commercial poultry supplemented the income from dairy cattle. Sheep were of no importance.

Dairy herds ranged from 12 to 120 animal units, averaging 32 in the Chicago area and 23 in the St. Louis. Producing cows comprised 70 percent of the dairy-animal units in the Chicago area and 67 percent in the St. Louis area.[1] In both areas cows of the larger breeds predominated.

Most of the 350 farms included in the study marketed relatively high-grade milk. Grade A milk was produced on 241 farms, Grade B on 60, unclassified milk on 41, and butterfat on 8 farms. All but 10 sold bulk milk, 8 sold butterfat, and 2 sold milk on the retail market.

FARM AND DAIRY INVESTMENTS

Service buildings, on 329 farms for which complete financial data were available, were 17 percent of the total capital investment of more than 18 million dollars (Fig. 2). When adjusted for changes in price levels, the distribution of this investment among land (including fencing), buildings other than homes, power and machinery, and productive livestock is comparable to that for the state of Illinois as shown by the United States Census of 1940, except that in the census the value of farm dwellings is included. Investments chargeable to the dairy enterprise on the farms in this study totaled 3.8 million dollars. Dairy buildings accounted for 49 percent of this amount.

[1] A dairy-animal unit is one mature cow or the feed-consuming equivalent of other dairy stock.

Distribution of Farm and Dairy Investments

Farm investments chargeable to the dairy enterprise include those for buildings, dairy stock, feed, and equipment.

When dairy buildings were not used exclusively for dairying, the percentage of the investment charged to dairying was the same as the percentage of space occupied by dairy cattle. Thus if approximately 50 percent of a barn was given over to cows, half the value of the barn was charged to dairying. The same method was used for determining the investment in feed-storage facilities including silos and in estimating investment in the water system chargeable to dairy cattle.

Unexpired portions of farm building insurance premiums were included in the building investment.

Table 1. — Farm and Dairy Investments, 1947, for 200 Farms in Chicago Area and 150 in St. Louis Area

Item	Chicago area		St. Louis area		Both areas	
	Percent of total farm investment	Percent of dairy investment	Percent of total farm investment	Percent of dairy investment	Percent of total farm investment	Percent of dairy investment
Service buildings	16	46	20	53	17	49
Land and land improvements	62	(a)	57	(a)	60	(a)
Power and machinery[b]	5	3	8	4	6	3
Productive livestock	10	30	7	23	9	27
Feed	7	21	8	20	8	21
Total	100	100	100	100	100	100

[a] Use of land was charged to the dairy enterprise in the form of feed costs for all farm-grown feeds utilized.

[b] Includes investment in horses and mules. This item covers only dairy equipment when referring to the dairy enterprise.

From one-sixth to one-fifth of the total capital investment on the farms studied was in service buildings. The proportion was higher in the St. Louis area than in the Chicago area.

Dairy buildings usually account for about half of the total dairy investment, but in the St. Louis area they accounted for more than half. (See Table 1.)

Investment Balance

Buildings and land. The building-land investment balance for the two areas is shown in Table 2. The value and the productivity of land is lower in the St. Louis area, and the investment in buildings per $100 invested in land is higher than in the Chicago area.

Metropolitan influence may be reflected more in the Chicago area than in the St. Louis, but most of the higher land value (nearly double

Table 2. — Inventory Value of Buildings of Different Ages per $100 Invested in Land

Item	Chicago area	St. Louis area
Land value per acre[a]	$195	$104
Inventory value of buildings per $100 of land investment		
Older buildings[b]	16	21
Medium-age buildings[b]	25	30
Newer buildings[b]	41	49

[a] Determined on the basis of soil-productivity ratings prior to World War II.

[b] Older, medium-age, and newer buildings are those having less than 41, 41 to 65, and more than 65 percent, respectively, of their original values remaining.

that of the St. Louis area) can be explained by higher soil productivity. When land is of low productivity as in the St. Louis area, farms are more apt to become overcapitalized. Under such circumstances it is hard for farmers to keep their building investment low relative to their land investment. Under 1947 price conditions the newer buildings in the St. Louis area were valued at nearly half the value of the land.

Overcapitalization, however, had taken place in both sections. The investment required to construct an average dwelling and replace existing service buildings would, on many farms in both areas, approach or even exceed the value of the land.

On only 7 percent of the farms in the Chicago area did the investment in buildings exceed $60 per $100 of investment in land, whereas in the St. Louis area 21 percent of the farms exceeded this figure. Also compared with St. Louis the Chicago area had 13 percent more farms with building investments that were below $30 per $100 of land.

A major problem for farmers is to maintain proper balance between service units and direct producing units. It is especially difficult to achieve economical investments in buildings comparable to those possible with the more flexible types of working capital such as livestock or farm machinery. This holds true both for those who are adding improvements and for those who are contemplating buying.

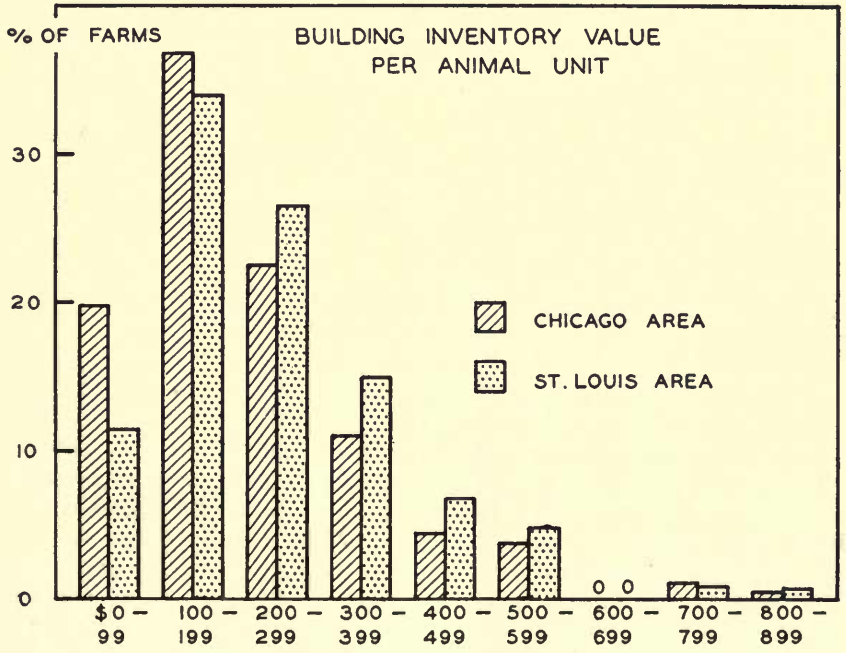
Buildings and livestock. Buildings on the farms studied were used primarily to service livestock. In each area approximately 60 percent of the farms had building inventory values from $100 to $299 for each productive animal unit.[1] Those in the St. Louis area tended toward

[1] Existence of waste space, or crowding of animals, as well as structural differences, influences the investment in buildings and their annual cost per animal unit. The range in investment and annual cost per unit of livestock indicated in several instances herein, suggests the desirability of case studies to determine the reasons for some of these extremes. Where successful operations are associated with low investment and annual cost of buildings per unit, such studies would be particularly useful.

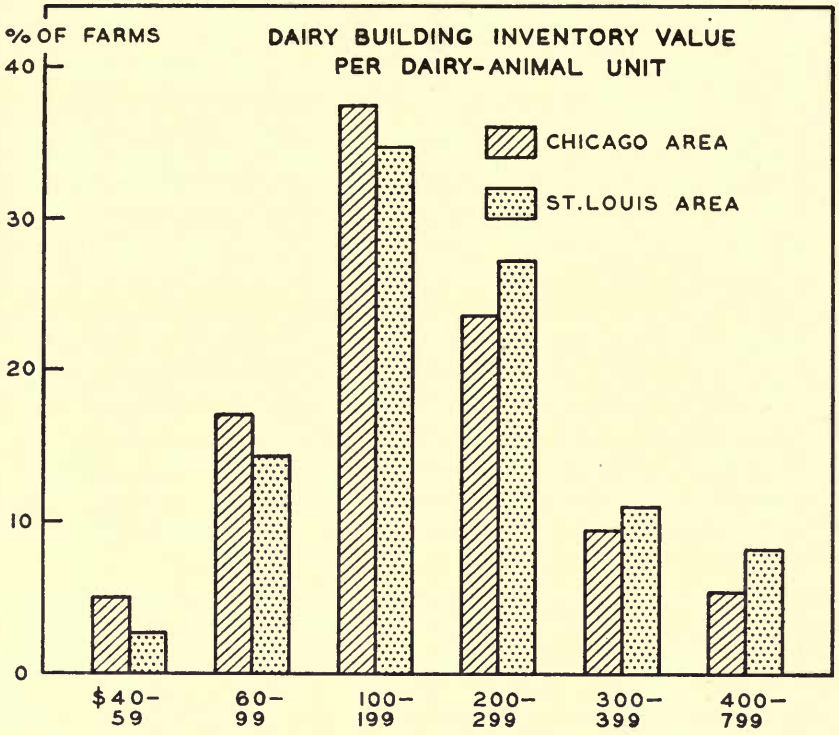
higher investment per animal unit than those in the Chicago area. Such a tendency cannot be explained by the greater proportion of dairy animals to all producing animal units on the farms in the St. Louis area (Fig. 3).

The cost of replacing these buildings in the same form and with the same materials would be $350 per dairy-animal unit in the Chicago area and $372 in the St. Louis area. As nonproducing animals comprise about 30 percent of the average herd in both sections, this outlay in either milkshed would be more than $500 for each cow milked. (See Figs. 4 and 5.)

In any industry investments in buildings should be related to the productivity of the enterprises they serve. For this study herd-inventory figures were considered to reflect the productivity of the farm dairy enterprise. When the value of dairy herds was compared with the investment in dairy buildings, the ratio was found to be more favorable in the Chicago area than in the St. Louis area. For each $100 invested in dairy stock, replacement of all dairy buildings in



Building values on more than half the farms, both in the Chicago and the St. Louis area, were from $100 to $300 per animal unit. (Fig. 3)



The dairy buildings on most farms in this study were valued from $100 to $300 per dairy-animal unit. Differences in value reflect economy of construction and use, and age of the buildings. (Fig. 4)

their original form at 1947 prices would require $286 in the Chicago area and $395 in the St. Louis area. The comparison is similar when depreciated building-inventory values are used. Table 3 shows these relationships in the form of a frequency distribution.

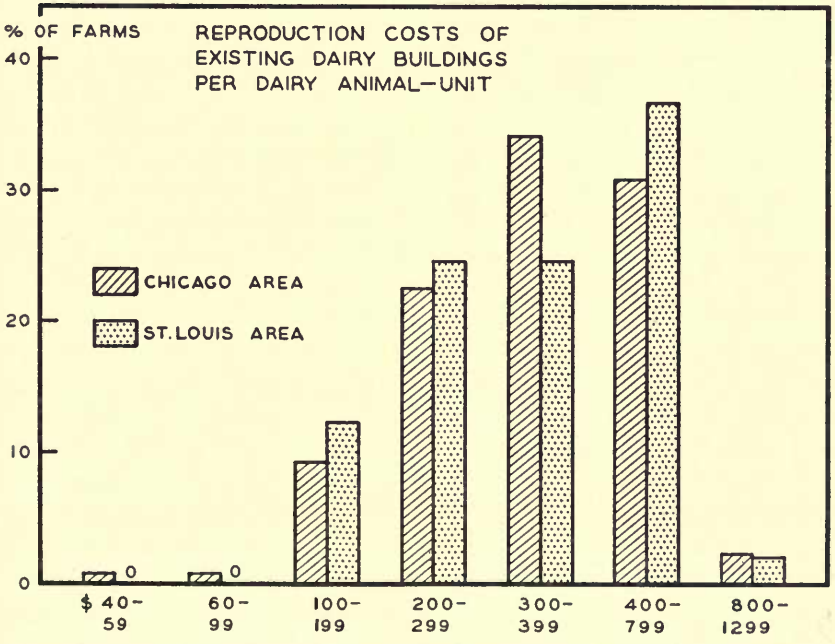
The inventory value of the older dairy buildings was about equal to the investment in dairy stock, while the value of the newer buildings was approximately three times as much.[1] On most farms the reproduction cost of dairy buildings ranged from $200 to $800 for each $100 invested in dairy stock. The average farmer interested in buildings similar to those studied may expect to spend, at cost-price relationships existing in 1947, approximately $300 to each $100

[1] Older, medium-age, and newer buildings are those having less than 41, 41 to 65, and more than 65 percent respectively of their original values remaining.

invested in dairy stock. However, it is no longer necessary to build barns as large as those included in this study because of changes in methods of handling roughage, particularly the use of baled hay, chopped hay, and grass silage. Farmers who prefer simple structures and less expensive materials may be able to erect functional buildings at a cost more nearly equal to their investment in stock. It should be remembered that high investment does not guarantee a functional building. Buildings which were in the upper levels of investment relative to $100 in dairy stock did not receive higher functional ratings than those in lower levels.

Investments per Farm

In 1947 in the Chicago area total farm-inventory values averaged $68,011, of which $13,068 was in the form of dairy investments. In



Reproduction of existing buildings would cost from $400 to $800 per dairy-animal unit on a third of the farms. Most buildings in this group are more elaborately constructed than necessary and, in many cases, waste space. Some buildings costing from $100 to $400 per dairy-animal unit have the facilities of a complete dairy plant, while others in the same cost range lack such facilities. (Fig. 5)

Table 3. — Dairy Building Investment per $100 Investment in Dairy Stock

Dairy building investment per $100 investment in dairy stock	Number of farms, Chicago area				Number of farms, St. Louis area			
	Old buildings[a]	Medium-age buildings[a]	Newer buildings[a]	New[b] (all groups)	Old buildings[a]	Medium-age buildings[a]	Newer buildings[a]	New[b] (all groups)
$40- $59	11	1	1	0	2	0	0	0
$60- $99	25	13	4	2	10	6	2	0
$100- $199	23	34	13	29	18	25	6	14
$200- $299	3	8	25	67	2	15	17	36
$300- $399	1	3	9	38	0	5	13	30
$400- $799	0	1	7	43	1	4	20	57
$800-$1,299	0	0	0	3	0	0	1	10
Total	63	60	59	182	33	55	59	147

[a] Farms classified by inventory value of dairy buildings in 1947 per $100 investment in dairy stock.
[b] Classified on basis of cost of reproducing all existing dairy building at 1947 prices.

the St. Louis area in the same year the average total farm investment was $41,820; the average dairy investment, $9,513.

The inventory values of all service buildings on the 350 farms studied (Table 4) ranged from a little over $4,000 per farm to a little over $21,000.

Total dairy investments per farm in the St. Louis area averaged 73 percent of those in the Chicago area. Of greater significance is the allocation of investment within the dairy enterprise itself. In the St. Louis area the investments in dairy buildings per farm were about 85 percent of those in the Chicago area, while the investments in dairy stock were only 56 percent of those in the Chicago area.

The inventory value of dairy buildings on all farms in both areas ranged from slightly more than one-third to nearly two-thirds of the total dairy investment per farm, depending on the amount of depreciation charged to the buildings (Table 5). The average cost per farm of reproducing all dairy buildings at 1947 prices would exceed $6,000 on 84 percent of the farms in the Chicago area, but only 65 percent of the farms in the St. Louis area would require $6,000 or more.

Table 4. — Inventory Value of All Service Buildings per Farm

Size of farm	Inventory value of—		
	Older buildings	Medium-age buildings	Newer buildings
(man-work units)[a]			
170- 325	$4,360	$ 6,750	$ 8,850
326- 405	4,680	6,230	11,660
406- 505	5,680	8,450	12,940
506-1,390	7,710	12,580	21,450

[a] One man-work unit equals the amount of work done by an average worker under average conditions during a ten-hour day.

Table 5. — Total Dairy Investment and Dairy Building Investment per Farm

Age of buildings	Total dairy investment per farm	Dairy building investment per farm	Percent of total dairy investment in buildings
Older	$ 8,672	$ 3,046	35.1
Medium age	10,134	4,579	45.2
Newer	14,836	8,458	57.0
New[a]	15,858	10,018	63.2

[a] Assuming reproduction of all dairy buildings at 1947 prices.

Larger dairy enterprises in the Chicago area account for a major portion of this difference.

Need for greater flexibility in buildings. Farmers, and dairymen in particular, have a high ratio of fixed to total costs. Also, prices for farm products fluctuate more than prices received by investors in most nonfarm industries. These conditions emphasize the importance, when constructing or remodeling farm buildings, of following a plan that can be rather easily adapted to shifts in the type or size of the farming enterprises. Even when the investment in a building has been fully recovered, the building itself may become a burden if it cannot be made to serve efficiently new uses demanded by changed conditions. Many types of farm dairy buildings do not even permit economical expansion in order to adjust to a larger herd.

It is true, of course, that some farmers may change the size of their business and even their type of farming without making commensurate changes in their buildings, for building changes are often hard to make. They may even add a dairy business without building new structures or remodeling the old. Consequently there is less relation between type and size of business and building investment than there would be if buildings could be as easily adjusted to varying demands as are some other production facilities, such, for example, as farm implements.

Most of the buildings on the farms studied were forty to seventy years old when this survey was made. They had been built when these farms produced mostly grain and meat animals. With growing populations in the nearby cities of Chicago and St. Louis, changes in food habits, and improved transportation, it was natural that many farmers should add dairying to their enterprises or shift to it exclusively. But few of the buildings were altered to any significant extent. Newer production methods, the introduction of mechanical power, shortage of labor, and its high cost all serve to emphasize the inadequacies of many of these buildings.

Table 6. — Dairy Building Investment per Dairy-Animal Unit in Relation to Size of Herd and Structural Level of Buildings (85 Farms)

Number of dairy-animal units in herd	Building investment per dairy-animal unit where average structural level was—			
	1.0-1.15	1.16-1.75	1.76-3.0	All levels
12-19.9	$607	$413	$368	$448
20-27.9	444	391	362	393
28-35.9	354	305[a]	358	342
36-59.9	336	375[a]	316[a]	340
All herd sizes	387	375	356	375

[a] Less than five farms included in the average.

The types of buildings found in use on farms included in this study do not permit reductions in building investment per dairy-animal unit as size of herd increases. Although a few farms within a selected group show a downward trend as size of herd increases, only 10 percent of that change can be attributed to increased scale of operations.

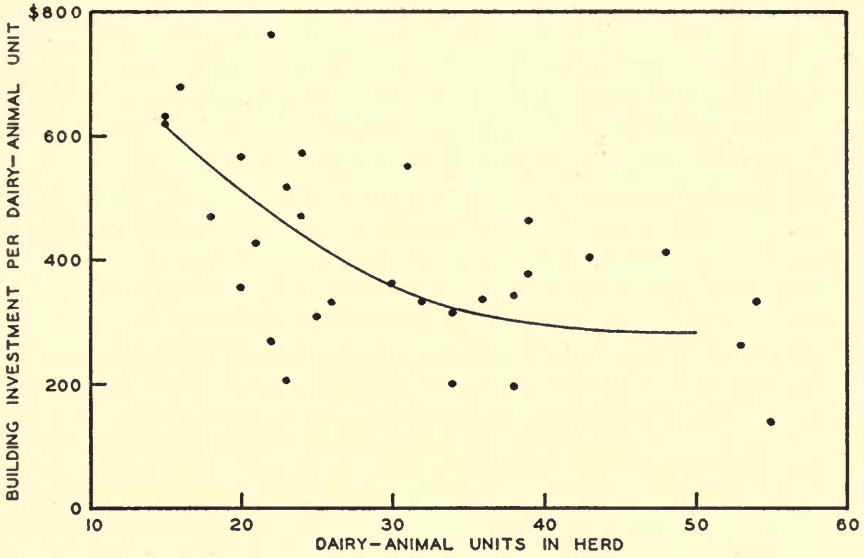
Effect of size of herd on building investments. In order to examine as accurately as possible the effects of different sizes of herds on building investments, steps were taken to exclude other influences. *First,* all farms on which waste space or crowding of cows occurred were eliminated from the comparison. *Second,* all farms were left out on which more than 80 or less than 66 percent of the total dairy units were milked. A farm with a high proportion of young stock ordinarily would have lower unit investments since young stock require relatively inexpensive housing. *Third,* extremely large herds were omitted as there were too few of them from which to draw conclusions.

After screening, 85 farms remained of the original 350. These 85 farms, in order to eliminate the influence of structural differences, were classified according to the average structural level of the dairy buildings.[1] For example, buildings falling into the structural level group 1.0 to 1.15 (Table 6) range from all "A" structural level to 85 percent "A" and 15 percent "B" structural level. Those in group 1.76 to 3.0 range from 25 percent "A" and 75 percent "B" structural level to all "C" structural level.

Table 6 shows the average reproduction building investment per dairy-animal unit for the 85 selected farms.[2] Average unit investments

[1] Structural level refers principally to characteristics of buildings that indicate permanency and completeness as to details of construction. See footnote, page 17, for a more complete definition.

[2] It is recognized that most farmers would not rebuild the same structures that they now have. But analysis on a replacement cost basis insures comparability among farms with respect to existing buildings.



In the case of buildings of the highest structural level, the building investment per dairy-animal unit decreased somewhat as the size of the herd increased. However, influences other than the size of herd are more important in determining unit investment. (Fig. 6)

for the different size groups indicate that farmers having buildings of the highest structural level profit from having large herds, but that it is difficult for them to obtain low investments in buildings for small herds. The difference in the average unit investment in dairy buildings for the different sizes of herds is very small on farms having dairy buildings of medium to low structural level.

The investment in buildings per dairy animal unit as related to size of herd for each farm having dairy buildings of the highest structural level, 1.0 to 1.15, is shown in Fig. 6. The extent of dispersion indicates that factors other than size of herd are responsible for a large part of the differences in unit investments. For herds of 20 to 25 dairy-animal units, the investment per unit in buildings varied from about $200 to nearly $800. On these farms building investment per dairy-animal unit decreased at a diminishing rate as size of herd increased to a maximum of 40 to 48 dairy-animal units. Diseconomies to scale might occur at some point beyond which further increases in size of herd would not lower building investments per dairy-animal unit. However, the data shown in Table 6 did not provide an adequate basis for locating such a point.

Only farms in the group having buildings of the highest structural

level revealed any variation in unit investment that could be attributed to size of herd. Of that variation only 10 percent was attributable to difference in size of herd. If the buildings had been planned so that they could be readily enlarged, there would have been more relationship between size of herd and unit investment.

A durable building is usually expensive and cannot be replaced economically until most of the initial investment has been recovered. Much of the current problem, therefore, is to improve present buildings through well-planned remodeling. As new buildings are constructed, they should be made flexible even at the cost of some permanency. Owners should not exclude from consideration, however, the possibility of combining low cost, flexibility, and adequate permanency. General plans for combining these desirable features in buildings are shown in Figs. 14 through 22.

FACTORS RELATED TO FUNCTIONAL CHARACTERISTICS

The size of herd, age and structural level of buildings, investment, and market grade of milk were studied in relation to the functional characteristics of dairy buildings.

Size of herd. Variation in the number of dairy-animal units in the herd was associated with one-fifth of the variation in the functional ratings of the buildings. Farmers who are devoting their resources largely to dairy production have constructed and maintained buildings with more of the desirable characteristics than have farmers with small herds. Table 7 indicates the effects of size of herd and age of buildings on functional ratings of buildings.

Age of buildings. Twelve percent of the variation in functional ratings was associated with differences in the age of buildings. In the newer buildings functional contribution tends to be higher for at least three reasons. *First,* some essential parts deteriorate with the passage

Table 7. — Functional Ratings of Dairy Buildings Classified by Size of Herd and Age of Buildings

Dairy-animal units in herd	Average functional rating for buildings			
	0-15 years old	16-25 years old	26 years and over	All age groups
12.0- 19.9	73	66	66	68
20.0- 23.9	78	70	70	72
24.0- 31.9	77	74	67	73
32.0-120.9	82	79	79	80
All size groups	78	73	70	73

of time. Concrete floors may crack and obstruct cleaning operations, gates and doors become loose, and many other faults develop. Deterioration, however, is not the major cause for lower ratings of older buildings. *Second,* the conversion of older buildings for use in dairy production has been incomplete. In many cases, knocking down horse stalls and putting in cow stalls were the only changes made. *Third,* older buildings were constructed without knowledge of many of the current requirements for efficient production of high-quality milk.

New technological developments may be largely responsible for the higher ratings of the newer buildings. However, even though progress has been made in building design, arrangement, layout, and construction, such improvements have been slow in appearing on farms. On the farms studied the average improvement in functional ratings of the buildings has been only one point for each three and one-half years reduction in age.

Structural level. On farms in the St. Louis area the functional ratings tended to be higher with buildings of higher structural level, nearly 20 percent of the variation in the ratings being associated with differences in structural level.[1] But in the Chicago area there was practically no relation between functional characteristics and structural level. There, the more rigorous climate and generally higher incomes may have tended to bring about construction of buildings of uniformly higher structural level regardless of the purposes for which they were built. In the St. Louis area, however, where the climate is milder and there is a greater variation in income, the structural level of the buildings varied widely. This was especially true when owners had shifted to the production of Grade A milk, since compliance with legal requirements and changes instituted for their own convenience tended to raise the structural level of their buildings. However, a high structural level in buildings may not mean ease in producing milk of high grade.

[1] Dairy barns classified as of high (A) structural level have good concrete or brick foundations of good depth and height. Floors are of smoothed and properly formed concrete. The walls and ceiling are sealed; the stall and stanchions are of steel. Barns of intermediate (B) structural level have foundations of stone mortared together; concrete blocks; or skimpy, thin, crumbling, noncontinuous poured concrete walls. Floors are of low-quality rough concrete or wood. The walls are not finished inside of studs; the stalls and stanchions are of steel. Barns of low (C) structural level have foundations of loose rock, piers, poles, or other similar material. Floors are of earth or wood laid on the ground. Such buildings have unfinished walls, and stanchions and feed boxes are made of wood. The definitions were adapted from the *Illinois Real Estate Appraisal Manual,* 1942.

Some of the improved designs for dairy buildings, especially those for loose housing, indicate that it will be possible to obtain both permanency and high functional ratings in dairy buildings at an investment equal to or even lower than that of most existing buildings.

Investment in buildings. No measure for building investment could be found which would give completely accurate results in examining the relation of investment to functional contribution. Since depreciated or inventory value ordinarily decreases more rapidly than does functional value, reproduction cost was preferred in this study. Even reproduction cost, however, is not a thoroughly desirable measure because few farmers would construct buildings exactly like those now on their farms.

Of the variation in functional rating on farms included in this study only 4 percent could be attributed to differences in the reproduction cost of existing buildings. Part of the reason for this nonrelation illustrated in Table 8 lies in the inadequacy of reproduction cost as a measure of investment in buildings, but most is due to certain specific factors closely associated with the physical nature and use of dairy buildings.

In the high-investment group, three-fourths of the buildings were of highest structural level, compared with about one-fifth in the low investment group. High structural level in the prevailing dairy housing systems is generally associated with costly materials and expensive types of construction, but as has been previously stated the use of such materials and types of construction does not necessarily increase the functional status of the buildings.

Of the farms in the high-investment group, three-fourths were producing Grade A milk, compared with only three-fifths of those in the group having lowest investments in buildings. Many owners who shifted to Grade A increased their investment in order to meet

Table 8. — Functional Ratings of Dairy Buildings Classified by Replacement Cost (1947) and Age of Buildings

Reproduction cost of dairy buildings per dairy-animal unit	Average functional rating for buildings—			
	0-15 years old	16-25 years old	26 years and older	All age groups
$100-$199	77	69	71	71
$200-$299	80	71	62	70
$300-$399	76	74	71	74
$400-$499	79	74	73	75
$500-$799	81	77	72	76
All investment groups	78	73	70	73

Table 9. — Functional Ratings of Different Classes of Features of Dairy Buildings Classified According to Grade of Milk Produced

Grade of milk	Average functional rating in Chicago area for building features affecting:			Average functional rating in St. Louis area for building features affecting:		
	Production, health, and safety of cows	Labor efficiency and safety of operator	Quality of milk	Production, health, and safety of cows	Labor efficiency and safety of operator	Quality of milk
A	36.8	18.2	22.2	36.5	17.3	21.7
B	34.9	16.3	16.6	33.7	15.1	18.2
C	36.5	15.8	16.8	31.4	13.3	14.9
Possible rating	45	25	30	45	25	30

certain requirements but did not necessarily increase the functional quality of their buildings.

On farms in the upper 10 percent based on investment in buildings per dairy-animal unit, 72 percent of the dairy-animal units were producing cows; on farms with lowest investments only 64 percent. This means that on the farms in the latter group there was a higher proportion of young stock. Young stock utilize relatively low-cost structures. This condition is not an undesirable one, but it does make it difficult to establish a clear relationship between investment and the functional characteristics of dairy buildings in more general use.

Crowding of animals was reported on 61 percent of the farms having lowest investments in buildings and on only 25 percent of the farms having highest investments in buildings. Conversely waste space was observed on nearly two and a half times as many farms in the high-investment group as in the low-investment group. Either crowding or wasting space reduces the usefulness of the building. Wasting space, however, increases investment per animal unit, while crowding results in low investment per animal unit.

Market grade of milk. The functional rating of buildings also varied with the grade of milk produced (Table 9). After eliminating the effects of investment, age, size of herd, and structural level, it was found that in the St. Louis area farms producing Grade A milk had buildings which rated 10.2 points above those on farms producing Grade C milk[1] and 3.1 points above those on farms producing Grade B milk. In the Chicago area on farms producing Grade A the buildings rated 6.5 points higher than those on farms producing Grade C, and 5.7 points higher than those on farms producing Grade B milk.

The functional rating of those features of the buildings related to

[1] Grade C includes milk not used for fluid consumption and butterfat.

quality of milk and efficiency in the use of labor varied consistently with grade of milk produced in both areas. Farmers producing Grade A milk generally have a more efficient over-all set of dairy buildings. When farms are classified according to grade of milk produced there is more difference in the average ratings of those building features assumed to affect quality of milk than in those affecting production or efficiency in the use of labor. This merely means that operators producing Grade A milk generally adhere more closely to structural and facility standards usually considered necessary for producing such milk than they do to standards related to efficiency in production.

In summary, size of herd, age and structural level of buildings, and investment in buildings per dairy animal unit combined are associated with about 38 percent of the variation in the functional rating of buildings in the Chicago area and 46 percent in the St. Louis area. The major portion of the remaining variations can be attributed to management decisions at the time of construction. For example, preferences for expensive materials or elaborate construction may increase investment without affecting functional characteristics. Possibly some of the variation may reflect inadequacies in the rating system.

FARM AND DAIRY COSTS

Items usually identified in determining total farm costs are land, improvements (primarily buildings), power and machinery, labor, feed, taxes, livestock, and miscellaneous. In determining total farm costs, the cost of farm-produced feed is included in the land, labor, and power and machinery costs. Only cash expenditures for feed and interest on the investment in feed inventories are identified as "feed" costs in arriving at total farm costs.

Most cash costs other than taxes and interest payments are variable — they depend on the nature and extent of operations. But the noncash costs with the exception of unpaid family and operator labor are rather firmly anchored to investments. Most prominent among these fixed costs are depreciation, which is estimated on the basis of the expected period of service, and interest on investments. The total farm cost is then the sum of all cash expenses and the value of unpaid labor, plus the carrying charges on the fixed investments.

Relative Importance of Farm Costs

The proportion of total investment tied up in each production resource (land, buildings, cows, etc.) is far different from the proportion

Table 10. — Relative Importance of Different Classes of Cash and Total Farm Costs

Item	Chicago area		St. Louis area	
	Cash costs	Total costs[a]	Cash costs	Total costs[a]
	perct.	*perct.*	*perct.*	*perct.*
Land	..	11	..	9
Land improvements	6	5	5	4
Service buildings	5	10	3	10
Power and machinery	22	20	28	21
Productive livestock	5	5	3	3
Feed	38	21	42	22
Labor	17	24	13	28
Taxes	6	3	5	3
Miscellaneous	1	1	1	(b)
Total	100	100	100	100

[a] Total costs for buildings, power and machinery, and land improvement include cash costs plus interest and depreciation. For livestock and feed, total cost is the sum of cash expenses and interest on the investment. Total labor cost is the sum of cash for hired labor and the value of family labor. For land the total cost is interest on the investment.

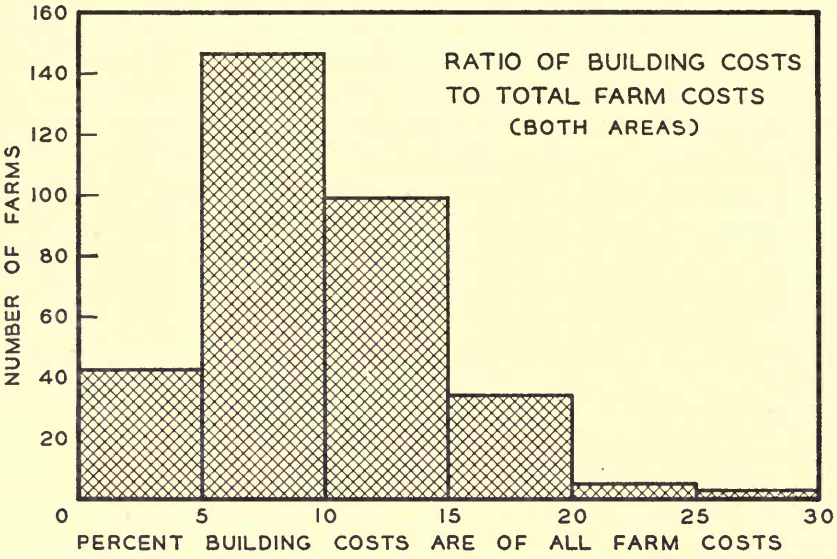
[b] Less than 1 percent.

of total cost each item represents. The durable investments (land, buildings) form the major part of the total investment but their annual costs are only a small part of total costs. Operating costs for such items as power and machinery, feed, and labor account for the major portion of all farm costs. Except for labor, which includes much unpaid family and operator labor, these operating costs account for a higher proportion of cash than of total costs. (Distribution of different classes of cash and total farm costs is shown in Table 10.)

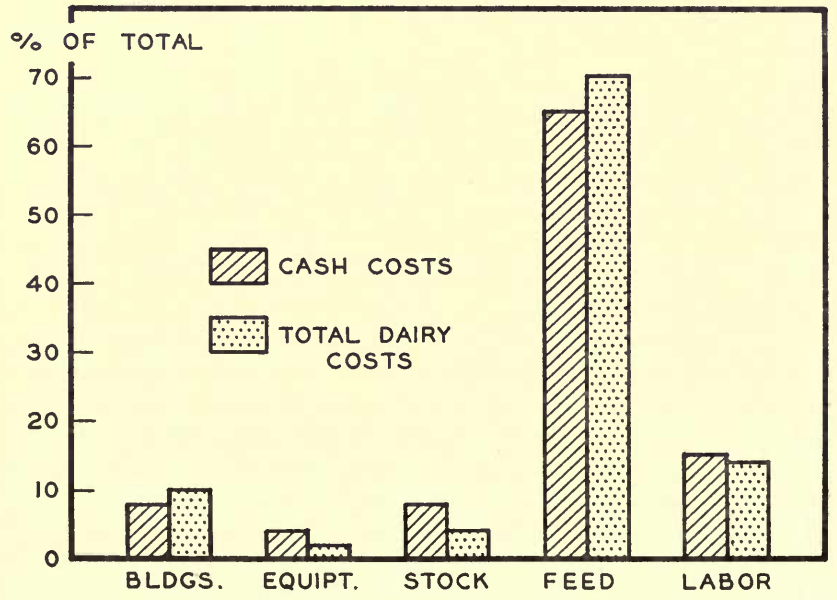
Cash costs are the actual cash expenditures for 1947 as given in the individual farm financial records, except for building maintenance and repairs for which the average cost over a six-year period was used after adjusting the cost each year for price level changes. This procedure was used because annual cash building costs on the same farm may be quite erratic. Cash outlays in 1947 for fertilizer, feed, labor, and other similar items were accepted as normal.

Building costs on the average were about 10 percent of total farm costs. They ranged from less than 5 percent to 30 percent (Fig. 7). When the quantity of a productive resource can be changed readily to conform to varying needs, its annual cost will vary with the size of business. However, size of business and type of farming had little influence on building costs in relation to total farm costs. As methods of production change, size of enterprise and types of farming change, but buildings do not change correspondingly.

The dairy enterprise was charged with the use of buildings, equipment, dairy stock, feed, and labor. Charges for buildings, equipment, and stock included interest, depreciation, and cash expenses; those



Variation in building costs relative to total farm costs emphasizes the difficulty of adapting buildings to meet changes in farm operations. (Fig. 7)



Buildings are of more value in the dairy industry than their proportionate costs (10 percent) would indicate. (Fig. 8)

Table 11. — Relative Importance of Cash to Total Costs of Specified Items Charged to the Dairy Enterprise

Items of dairy cost	Chicago area	St. Louis area	Both areas
	perct.	*perct.*	*perct.*
Buildings	23	16	20
Equipment	50	50	50
Stock	52	48	51
Feed	22	27	24
Labor	33	23	29
Total	26	27	26

for feed included interest, cash expenses, and the value of farm-produced feeds; those for labor, cash expenses and the value of unpaid labor. Interest for buildings was at 5 percent on the depreciated inventory value of buildings. Rates of depreciation were varied according to structural level and condition of buildings. Farm-produced feed was charged at 1947 market prices. The value of unmarketable feeds was established on the basis of feeding value relative to the feeding value of similar types of marketable feeds. Costs of producing feed were not identified as feed costs, but were included in the cost of labor, power, and machinery used in feed production.[1]

Cash expenditures for feed comprised 65 percent of all cash dairy expenditures (Fig. 8). Total feed charges represented 70 percent of total dairy costs. Building costs represented 8 percent of cash and 10 percent of total dairy costs. Feed expenditures were obviously more impressive than those for buildings. However, the contribution of buildings to the success of the dairy enterprise cannot be judged by direct cost relationships alone. For a true estimate, examination must be made of the effects of buildings on the quantity and efficiency in use of such inputs as labor and feed and on the price received for milk.

Table 11 shows that cash outlay for repair and maintenance of dairy buildings averaged 20 percent of total building costs. Cash building costs were a larger part of total building costs in the Chicago area than in the St. Louis area. No study was made of the influence of structural level on repair and maintenance costs.

Before examining building costs, it is well to observe the average costs per farm in the two areas.

[1] To the extent that the portion of these costs chargeable to feed production on the farm is less than the market value of such feed, the analysis indicates the competitive position of the dairy farmer (considering the farm as a unit) to be less favorable than it actually was. The cost of producing farm-grown feed fed to dairy cattle was estimated and was found to be about 40 percent less than the market value of this feed in 1947.

Table 12. — Average Cash and Total Costs per Farm

Item	Costs in Chicago area		Costs in St. Louis area		Costs in St. Louis area per $100 cost in Chicago area	
	Cash	Total	Cash	Total	Cash	Total
All farm costs						
Buildings	$332	$1,480	$169	$1,053	$51	$71
Land	....	1,622	....	927	..	57
Land improvements	433	711	257	469	59	66
Power and machinery	1,601	2,814	1,532	2,347	96	83
Livestock	350	681	143	298	41	44
Feed	2,707	3,000	2,242	2,416	83	81
Labor	1,214	3,437	694	3,030	57	88
Taxes	422	422	293	293	69	70
Miscellaneous	99	99	48	48	48	48
Total	7,158	14,266	5,378	10,881	75	76
Dairy costs						
Buildings	$190	$ 809	$104	$ 630	$55	$78
Equipment	82	165	68	137	83	83
Stock	216	413	99	207	46	50
Feed	1,364	6,123[a]	1,140	4,155[a]	83	68
Labor	364	1,097	212	921	58	84
Total	2,216	8,607	1,623	6,050	73	70

[a] All farm-grown feed fed to dairy cattle was charged at market prices, hence total dairy feed costs calculated in this manner are higher than total farm feed costs. See footnote on page 23.

Average cash and total costs per farm in the St. Louis area were about three-fourths those in the Chicago area (Table 12). Total costs for power and machinery, feed, and labor in the St. Louis area were substantially higher relative to those in the Chicago area than was the case for most other items. But costs per farm for land and livestock were relatively low in the St. Louis area.

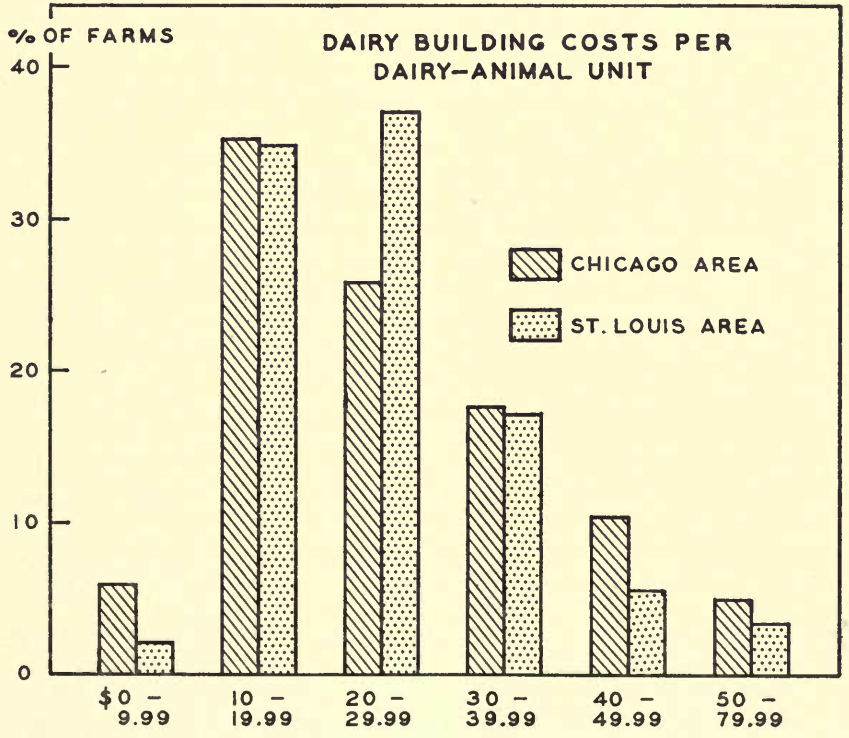
Cash expenses per farm for power and machinery in the St. Louis area were nearly equal to those in the Chicago area, and for feed they were 83 percent of those in the Chicago area. Compared with all cash farm expenses those for repair and maintenance of buildings were low in the St. Louis area. The same was true of land improvements and livestock. Cash labor costs were also relatively low in the St. Louis area, primarily because of smaller herds and use of more family labor.

Cash costs approximated 50 percent of total farm costs in each area (Table 12), but they comprised only about one-fourth of total dairy costs, principally because charges for farm-grown feed were added to dairy costs and comparatively little hired labor was used.

Dairy building costs may be presented in two ways, each having merit when used appropriately. *First,* over the usable life of a building a fixed rate may be applied to the original investment to cover depreciation, interest on the investment, and repair and maintenance costs. The amount of this annual charge will vary. An appropriate

range may be from 6½ to 8 percent of the original investment. The average annual costs of medium-age buildings as classified in this study are approximately the same as if a constant rate had been applied to the original investment in buildings. *Second,* a cost covering these same charges may be computed each year from the current inventory value of buildings. Depreciation and repair and maintenance costs combined probably will be relatively constant over the years, but annual interest charges are at a maximum when a building is new and diminish annually as more of the original investment is recovered in the form of earnings attributable to the buildings.

Viewing dairy building costs in light of current inventory values is especially pertinent if borrowed capital has been used for construction purposes. Such a view also reflects the fact that the depreciated part of the initial investment is presumably recovered each year in



The two areas differed very little in average dairy-building cost per dairy-animal unit. (Fig. 9)

the form of earnings and it is not appropriate to charge interest on this portion. To obtain the true situation for a particular farm, interest costs are properly computed on the basis of the current inventory value of the buildings. This method is followed in this report.

Dairy building costs with interest charges based on current inventory values ranged from a low of $3.32 to a high of nearly $80 per dairy-animal unit. These costs are shown without respect to age of buildings in Fig. 9. With the ordinary set of dairy buildings now on farms, the average annual cost would be about $26 per dairy-animal unit or $38 for each producing cow. Careful planning in future construction and consideration of the various types of low-cost dairy buildings available can reduce these costs substantially.

Size of Business and Building Costs

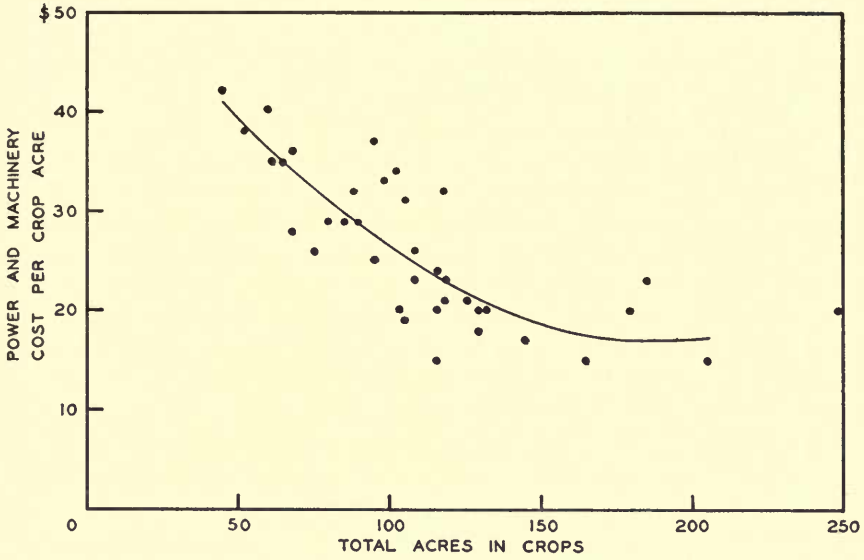
Depreciation and interest, comprising about 80 percent of building costs, are tied directly to investment. It is logical to assume that building costs per dairy-animal unit would be related to size of herd much as was investment per dairy-animal unit. And it was found that building costs per animal unit were about the same on farms with large herds as on those with small. Costs per dairy-animal unit did not differ significantly among the four sizes of herds considered (Table 13). In fact, because there were so many other factors influencing the relationship, there was even less economy to scale in terms of annual cost than in terms of investment.

For the farm as a whole, average building costs were slightly less than $3 per man-work unit but they varied erratically among groups of farms. Other measures of size of farm business such as total crop acres and number of productive animal units gave similar results.

Cash farm and family living expenditures vary from farm to farm. These are expenses which have to be met, while farm building repairs can be postponed and often are. Management, types of buildings, and

Table 13. — Average Annual Dairy Building Costs per Farm and per Dairy-Animal Unit for Herds of Different Sizes

Dairy-animal units per farm	Costs for older buildings		Costs for medium-aged buildings		Costs for newer buildings	
	Per farm	Per unit	Per farm	Per unit	Per farm	Per unit
12.0- 19.9	$268	$16	$380	$22	$671	$41
20.0- 23.9	405	19	497	23	928	42
24.0- 31.9	422	15	663	24	960	35
32.0-120.9	832	18	950	23	1,525	34

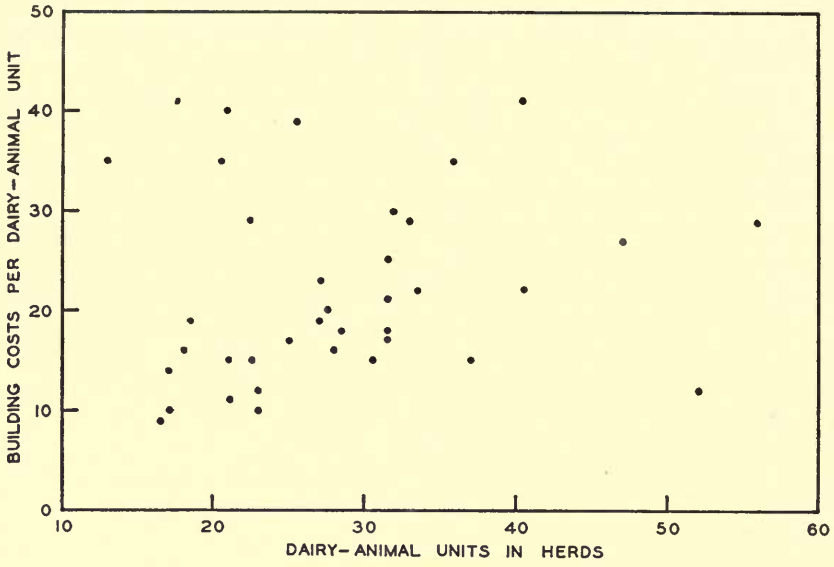


Power and machinery costs per crop acre tend to decline as more acres are handled. (Fig. 10)

net farm income are also never quite the same on one farm as on another. All these variations help to explain the irregularity in annual cash building costs found in both large and small dairy businesses.

Since most of the total building cost is made up of interest and depreciation, decisions made at the time of construction are responsible for the relatively high annual cost of buildings on many farms. The problem is to make such costs reflect more nearly the current contribution of the buildings.

Building costs are less flexible than power and machinery costs — they cannot be adapted so closely to current needs of the farm business. In this study large farms (Fig. 10) tended to have lower machinery costs per acre than small farms. But farms with small dairy herds had low building costs per dairy-animal unit about as often as did those with large herds (Fig. 11). Even when the buildings considered were new, costs were not appreciably lower per dairy-animal unit on farms with larger herds. When buildings were classified as to structural level, as in Table 6, and only those using space to best advantage were compared, there was a slight tendency toward lower unit building costs on farms with larger herds. However, economy to scale was still small compared with that shown for farm machinery. Dairy buildings may never offer lower costs with increased size of enterprise



Size of business had little effect on the annual cost of most existing dairy buildings per unit of operation. Farms are the same as in Fig. 10. (Fig. 11)

to the extent possible with more flexible inputs. But new developments should make substantial progress in this direction.

Indirect Dairy Building Costs

The importance of buildings in dairying cannot be estimated from direct costs alone. Including charges for depreciation, interest, repair, and maintenance, direct building costs averaged only about 10 percent of total dairy costs. Such an amount when deducted from gross returns may seem overshadowed by the cost of other items such as feed, which generally exceeds 60 percent of all dairy costs. However, this 10 percent chargeable to the use of buildings represents the purchase of services affecting the efficiency and economy with which other dairy inputs are used and the price received for milk.

One of the most obvious and important of these indirect effects concerns labor costs. The additional labor required in using poorly arranged and located buildings will not be reflected in direct building costs, yet it may cause dairy labor costs on one farm to be more than double those on another farm. Large reductions in labor requirements represent a real saving considering that dairy labor costs on the farms in this study averaged 15 percent of total dairy costs, an amount

50 percent larger than direct building costs. Low labor requirements per cow make possible the maintenance of the present herd with less labor or the operation of a larger herd with no additional labor.

Buildings may affect the amount of feed required and its quality. Improperly constructed mangers waste feed. Low-quality roughages may result from poor curing and storage facilities.

Sufficient space per cow and well-arranged feeding and resting areas contribute to the production of the cows and make the work of the operator easier. Waste space, however, adds to building costs without contributing to production or returns and may even increase labor requirements per cow. Narrow gates, high curbs, loose hinges, protruding nails, smooth finished floors in the cow area, and other such hazards may reduce the productive capacity of a herd. All of these can be found in high-cost as well as in low-cost buildings.

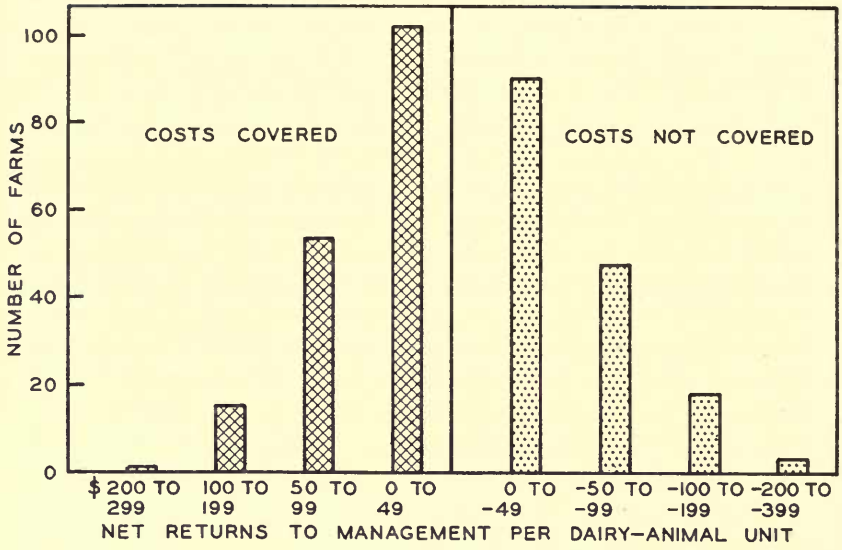
Fresh air without drafts and without excess moisture in the barn is another requisite for healthful dairy conditions during the winter. These conditions can be attained in low-cost buildings. In fact, it is often the expensive and enclosed buildings that have rotting sills and damp walls — evidence of poor ventilation.

Buildings and equipment should be so constructed that with good management milk can be easily produced without undesirable bacteria and foreign matter. Low-quality milk does not bring top prices. Such milk will reduce the income of a dairy organization that may be highly efficient in every phase except its sanitation program.

Little relation was found between annual cost and use value of buildings as measured by the rating system, regardless of the age of buildings. (For discussion of relation of functional value to replacement cost see page 18.) Part of this nonrelation may be attributed to the fact that the buildings studied were for the most part of a type difficult to remodel to meet changing needs. Such buildings were commonly constructed in the past and to a large extent are still being constructed. Also, much remains to be discovered about what building characteristics contribute to dairy production or returns.

RETURNS AVAILABLE FOR DAIRY BUILDING COSTS

For the question, "What is the lowest cost at which the essential functions can be furnished by farm dairy buildings?" solutions are suggested in the final section. In this section costs of existing buildings are analyzed in relation to the returns available to meet them.



In 1947 dairy returns on only 52 percent of the farms included in this study met all costs. (Fig. 12)

Net returns to management per dairy-animal unit (farm-grown feed charged at market prices) are shown in Fig. 12.[1] The two areas have been combined in this analysis as their returns to management were similar.

First it is necessary to see how profitable dairying was under 1947 price conditions. Net returns to management were used in measuring financial success because they reflect the inclusion of all inputs other than management. To arrive at net returns, total costs were subtracted from gross returns. Gross returns were the value of dairy products and dairy stock sold and consumed on the farm plus the value of net inventory changes. Total costs equalled the sum of charges for the use of buildings, equipment, dairy stock, feed, and labor.

Price-cost relationships were relatively unfavorable for dairying during 1947 because the price of feeds had increased much more than other prices and costs. Net returns to management varied widely, ranging from a loss of $333.39 to a gain of $203.31 per dairy-animal unit.

On most farms where the dairy enterprise showed a loss the cash farm income still exceeded total cash expenses. This was often true

[1] For an explanation of "farm-grown feed charged at market prices," see footnote on page 23.

even when dairying was the main enterprise. Such cash balances are, however, attributable not to efficiency of the dairy enterprise but to efficiency of crop and feed production and to the use of a large amount of unpaid family labor. It should be remembered also that all unpaid family labor and home-grown feeds were charged against the dairy enterprise at market value and therefore were reflected in the dairy accounting but not in the cash income of the farm. Dairy cows form a valuable addition to the general farm enterprise by providing a market for some nonsalable feeds and for family labor which might otherwise go unused and return nothing to the farm business.

Strict enterprise accounting becomes somewhat artificial when the farm business is considered as a unit. Feed for dairy cattle is often produced for much less than its current market value. Farmers who have large amounts of nonsalable feeds and unused labor rightly consider the dairy enterprise an integrated part of their farm business. The dairy enterprise is a market which will pay more than production cost for nonsalable feed and generally more than current prices for that part of it which is salable. To find the profit of the whole farm business the dairy enterprise must be considered as it ties in with other farm enterprises, not as a separate operating unit.

If, however, the success of dairying on individual farms is to be compared, the study must be made on the basis of enterprise analysis, the approach used in this report. In enterprise analysis all parts of the farm business are held constant except the one being studied; in this case, dairying. Standard prices must be used for all feed and labor whether furnished from farm sources or paid for in cash. In determining the returns available to meet dairy building costs, the use of market prices for all feed and fixed wage rates assured comparability among farms.

It is frequently held that building costs should be met out of what remains of dairy returns after other operating costs have been paid. And in fact, building costs may often be postponed and the whole enterprise may be operated for some time at little or no out-of-pocket expense for building upkeep. But eventually all costs must be met if the enterprise is to be justified. Therefore, charges adequate to cover the costs of each of the items entering into production should be made each year.

Returns from dairying result from a combination of all inputs — no returns would be obtained from any one of them in the absence of the others. Thus the returns available to meet a particular dairy cost were weighted according to the importance of that cost relative to total

dairy costs. For example, when dairy buildings accounted for 10 percent of total dairy costs, 10 percent of the gross dairy returns was considered the amount available to meet dairy building costs.

No satisfactory method of determining what proportion of gross returns should be allotted to management was developed in this study. Therefore, any returns which might have been due management were left in gross returns and distributed to the other productive factors (dairy stock, feed, labor, etc.) in proportion to the cost of these inputs. For example, if buildings account for 10 percent of all dairy costs, then 10 percent of the returns available for management was included in the figure here used to represent returns available for buildings. When gross returns failed to equal total costs there were no returns to management and losses were distributed among the various inputs in a similar manner.

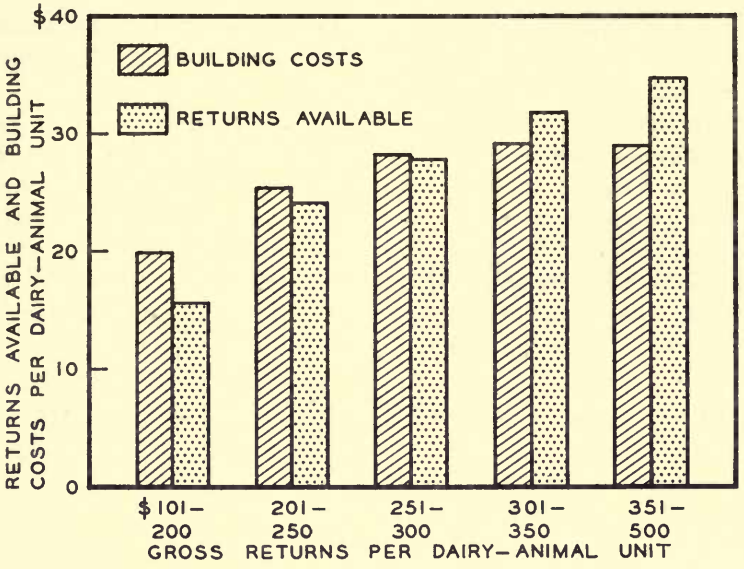
If the cost of buildings is proportionately higher than their contribution to returns, this allocative method will allow more funds for building costs than are necessary to provide essential functions.[1] However, gross returns taken from a large number of records and distributed in the above manner show what the farmers thought they needed and actually spent even though such an amount was more than enough to provide essential functions.

One of the reasons for this disproportion is the fact that farmers have not applied advanced techniques in building construction as rapidly as they have applied new discoveries affecting crop varieties, use of fertilizer, disease and pest control, and animal breeding.

Two conclusions may be drawn from Fig. 13. First, high gross returns were not dependent on high building costs. Although building costs were slightly lower where gross returns did not exceed $200 per dairy animal unit, such low returns undoubtedly reflected lack of good dairy management in general. As gross returns rose above $200 there was relatively little increase in dairy building costs per dairy-animal unit. Returns available to pay building costs increased about 45 percent in going from the second lowest to the highest income group, but building costs increased only 15 percent. Second, returns of about $300 per dairy-animal unit were necessary to cover all costs. Only about half the farms had such returns.

As calculated here, returns available to meet building costs averaged $25.53 and $27.04 per dairy-animal unit in the Chicago and St. Louis areas. Building costs per dairy-animal unit were $25.87 in the

[1] In the residual method sometimes used, costs of all other items are first deducted leaving the remainder, if any, to meet building costs.



High returns from dairying do not depend on high building costs. As gross returns rose from $200 to $500 per dairy-animal unit, there was little change in building costs. (Fig. 13)

Chicago area and $26.74 in the St. Louis area. Thus, average dairy returns in both areas were such that little or no margin was left after paying all costs other than management.

INVENTORY OF MANAGEMENT PRACTICES

One of the original purposes of this study was to determine the effects of management practices on dairy returns. With this in mind farmers were interviewed concerning practices which, on the basis of experience, were believed to influence success in a dairy enterprise. These were scored individually and summarized in major groups.

Most of the important aspects of dairy management were considered in this study. It was impossible to evaluate them all since management practices encompass the selection of dairy animals, types of buildings, and kinds of feed; the degree to which all of these are used; the allocation and combination of the various means at hand; and all of the marketing problems associated with the dairy enterprise.

Both observation and judgment show that use of buildings and management cannot be separated. Good management can often com-

pensate to some extent for the lack of good buildings. However, buildings which are properly designed and located aid in attaining efficient management.

Since management reaches into every phase of dairy operations and relates to investments, costs, and all other inputs, individual practices could not be assigned values which would give a true picture of their worth in a composite rating such as that used for evaluating the physical characteristics of buildings.[1] Without such a composite measure, management's effect on dairy returns could not be determined through correlations. However, the composite scores of ratings given to various practices and gathered into major groups reveal the areas in which

Table 14. — Ratings for Specified Dairy Management Practices

	Number of farms with rating of—				
	1.0	1.25-2.0	2.25-3.0	3.25-4.0	4.25-5.0
Utilization of space	42	224	74	10	0
Manner of handling cows	164	170	14	2	0
Control of pests, diseases, etc.	3	254	79	14	0
Breeding	32	188	118	1	11
Cleanliness of cows	80	40	157	40	33
Cleanliness of milking area	14	267	38	22	9
Milking practices	18	79	124	117	12
Cleanliness of milkhouse	91	170	46	34	9
Cleanliness of equipment	261	56	0	24	9
Milk cooling	126	67	145	5	7
Grain-feeding rate	10	81	63	70	126
Pasture-management practices	52	132	79	2	85
Protein content in ration[a]	20	133	100	65	32

[a] The standard used for protein content varied with the type of roughage. Legume hay was fed on 268 farms and mixed hay on 82.

farmers were following good management practices and those in which their practices could be improved.

The frequency of occurrence at different levels for most of the important dairy management practices is shown in Table 14. The numerical rating of 1.0 means that a particular practice met the standard. Ratings higher than 1.0 denote successively poorer management for any particular item. For example, ten dairymen who varied the grain feeding rate according to the production of each cow received ratings of 1.0, but 126 were given ratings between 4.25 and 5.0 because they fed equal amounts to all cows.

Use of space. When use of building space was surveyed, 328 of 350 dairymen were found either wasting space or crowding their cows

[1] See page 5 for description of composite rating of physical characteristics of buildings.

(Table 14). Waste and shortage of space in relation to the needs of the milking herd are brought out in the following tabulation:

	Considerable	*Moderate*	*Little*	*Total*
Waste space, farms	106	19	10	135
Shortage of space, farms	115	60	18	193
Total	221	79	28	328

Health of stock. The types of health problems found on these farms, some of which may relate to inadequacies of building arrangement or construction, are indicated in Table 15.

Of the 510 death losses shown in Table 15, 150 were cows from the milking herd. In addition, 1,647 milk cows from a total of approximately 7,500 were disposed of during the year. Culling for age and

Table 15. — Animal Health, Nature of Veterinary Services, and Causes of Death Losses

Item	Number of farms reporting health problem	Number of veterinary service calls reported	Number of animals reported lost through death
Udder problems	108	29[a]	10
Tuberculosis	85	0	0
Bang's disease	100	0	42[b]
Calving problems	0	118[c]	106[d]
Scours	0	6	103
Pneumonia	0	8	62[e]
Other diseases	0	0	8
Injury or poisoning	5	9	43[f]
Bloat	0	4	26
Miscellaneous	14	175[g]	43
Unknown	0	23	67

[a] Includes 20 recognized cases of mastitis.

[b] Only one was from the milking herd.

[c] Includes 35 recognized cases of milk fever.

[d] Includes 14 recognized cases of milk fever; 37 of the animals that died were cows from the milking herd.

[e] Only three were from the milking herd.

[f] Thirty-five were from the milking herd.

[g] Includes all vaccinations and tests.

low production accounted for 90 percent of the cows sold; disease, injuries, and miscellaneous causes for the remainder. About 25 percent of the cows carried in the milking herds on these farms were disposed of or lost during the year.

Breeding methods. In the general move toward high production, some drastic changes in breeding methods have occurred in recent years. The following tabulation indicates the number of herds using herd sires and those using artificial insemination.

Herd sire

Proven....52
Not proven....149

Artificial insemination

For complete herd....149
For half of the herd....50
For less than half....5
Not at all....146

Farmers who had shifted completely to the use of artificial insemination were not questioned as to the record of the sire. Included among the 52 proven sires are four which are not proven but of known high-producing ancestry.

Production records. Although for determining the most profitable grain-feeding rate, production records for each cow are essential, only 65 farms had adequate records. Forty-nine had partial records while 236 had none for individual cows.

Milking machine time. The length of time milking machines are allowed to remain attached influences both the health and production of cows. Too short a period will necessitate hand-stripping. Excessively long periods may cause damage to the udder. On the farms studied milking machines were reported to have been left on the cows for the following lengths of time:

Minutes attached	*Number of farms*	*Minutes attached*	*Number of farms*
Less than 3.0	13	4.1 to 5.0	68
3.0 to 3.5	129	5.1 to 6.0	7
3.6 to 4.0	115	More than 6.0	2

The average time per cow for all farms using milking machines was 3.9 minutes. In 16 dairies the cows were entirely hand-milked.

Table 16. — Farms Indicating Premilking and Milking Practices That Are Presumed to Influence Cleanliness and Quality of Milk

Frequency of practice	Clip udders and flanks	Wash udders[a]	Use strip cup[b]	Hand strip[b]	Pour milk in barn[c]	Sterilize teat cups (each cow)	Hand milk	Use lime on floor
				(number of farms)				
Regular	185	263	75	104	169	145	16	265
Occasional	17	22	22	67	11	85[d]	88	13
Not followed	148	65	253	179	170	120[e]	246	72
Total	350	350	350	350	350	350	350	350

[a] Separate cloth used for each cow on 118 farms.
[b] Strippings added to milk on 169 farms.
[c] An undesirable practice.
[d] More than one cow milked between sterilizations.
[e] Sterilizing solution not used.

Sanitation. The production of high-quality milk requires care in both the premilking and the milking operations. Table 16 shows how frequently some of the more important procedures were followed.

Also, sanitary conditions in the milkhouse must be maintained. Besides keeping the milkhouse clean, this requires sterilization of equipment and cooling of milk. Practices followed in this portion of the sanitation program are indicated below:

	Number of farms
Equipment washed and rinsed	
Boiling water with sterilizing solution	64
Only boiling water	9
Cold water with sterilizing solution	4
Only cold water	6
Water 115° with sterilizing solution	252
Only water at 115°	15
Equipment protected between milkings	
Kept in a sterile chamber	160
Inverted in a protected place	133
Inadequately protected	57
Milk taken to milkhouse	
Immediately	273
After some delay	77
Milk cooled	
Immediately	233
Within an hour	103
After an hour	14

Three farms used live steam in addition to water at not less than 115°.

PRESENT DAIRY BUILDINGS AND THEIR PHYSICAL CHARACTERISTICS

In measuring those details of construction and arrangement that are presumed to contribute to the success of the dairy enterprise and in dealing with them in this study, it was necessary to develop a rating procedure that evaluated both individual building characteristics and the dairy building organization as a whole. Detailed information regarding specific features was recorded at the farms and used in developing the ratings. The score given to each feature represented the degree of usefulness of that feature relative to the standard set in the rating procedure previously described (see page 5). The total rating for each set of farm dairy buildings and their associated facilities covers: (1) production, health, and safety of cows; (2) efficiency of chore operations and the safety of the operator; and (3) quality of milk.

Features of Dairy Buildings and Related Facilities

The different building characteristics were rated from 1.0 to 5.0 with 1.0 representing the standard and higher numbers, lower standards. For example, dirt floors in the milking area, considered one of the most undesirable types of flooring in that area, were rated 5.0. A frequency distribution of the farms given various ratings for different items is shown in Table 17.

In arriving at ratings on building characteristics and facilities a

Table 17. — Number of Farms Given Specified Ratings for Different Functional Characteristics of Dairy Buildings and Associated Facilities

Functional characteristic[a]	Number of farms with ratings of—				
	1.0	1.25-2.0	2.25-3.0	3.25-4.0	4.25-5.0
Items pertaining to production, health, and safety of cows					
Stall size	23	108	153	58	8
Manger and bunks	57	102	155	28	8
Alleys	68	90	104	66	22
Ceiling height	214	79	29	15	13
Young stock space	75	173	83	17	2
Floor material	237	78	9	4	22
Floor condition	164	140	17	18	11
Curb	210	100	12	14	14
Gutter	11	114	164	48	13
Walls	59	211	47	26	7
Gates and doors	134	32	100	68	16
Drafts	81	208	45	15	1
Condensation	66	233	49	1	1
Barn odors	120	212	14	2	2
Ventilation	9	189	138	12	2
Protection for concentrates	27	217	77	27	2
Roughage facilities	11	263	74	2	0
Water protection	38	116	111	59	26
Water adequacy	64	174	88	24	0
Items pertaining to chore-labor efficiency and safety of operator					
External layout	10	82	134	123	1
Handling cows	42	254	47	7	0
Handling milk	33	154	64	62	37
Feed preparation and feeding	14	194	102	38	2
Cleaning operations	13	154	65	18	100
Natural lighting	15	210	79	34	12
Artificial lighting	4	191	112	37	6
Bull pen	147	74	33	32	64
Electrical wiring	84	234	27	5	0
Other	5	188	113	37	7
Items pertaining to quality of milk					
Clean buildings	23	231	58	22	16
Clean cows	1	54	1	128	166
Cooling facilities	1	111	40	187	11
Facilities for washing and sterilizing	250	67	24	8	1
Water disposal	115	97	48	34	56
Utensils	144	172	30	4	0

[a] Each item represents a summary of several elements for which data were obtained.

great many details not shown in the tables had to be considered. Some of the facts gathered are discussed below.

Roughage facilities. Ratings were assigned to roughage facilities on the various farms (Table 17). These were based on the general principle that quality of roughage is affected by the method of curing and type of storage. It was found that of 350 dairy farmers, only 17 used any method of artificial curing, the remainder depending on curing their hay in the field. Hay was stored so as to obtain adequate protection from the weather on 327 farms and for partial protection on 13 farms. Only 10 farmers stacked hay in the open. One or more upright silos were found on 280 farms. There was only one pit and one trench silo.

Water facilities. These were rated (Table 17) with the fact in mind that water for the dairy herd should be plentiful and easily accessible at all times. Only 8 farms lacked an adequate supply of water, but accessibility was difficult on 65 farms while distribution was poor on 163. On 191 farms the approach to water was muddy, generally unclean, or otherwise undesirable. In addition the water supply on over 200 farms was not adequately protected from accumulation of foreign material. Tank heaters were present on 215 farms.

Ventilation. On 169 farms ventilation (Table 17) was obtained through windows hinged at the bottom so that no draft blew on the animals. Mechanical devices for providing fresh air were in use on 45 farms. There were 136 farms that relied on miscellaneous openings such as hay chutes, silo chutes, small doors, and, to a large extent, cracks in the walls. The standard for evaluating ventilation was whether fresh air was obtained without drafts, and beyond that no consideration was given to special devices.

Operating efficiency. The distances farmers travel in doing dairy chores provide one measure of chore-labor efficiency (Table 18). Such distances are determined chiefly by the physical arrangements of the dairy buildings but may be modified by the work methods of the operators. Some of the farmers included in this study had to contend with poorly arranged buildings, but they had devised ways of saving steps so that they got more work done in less time and with less expenditure of energy than many who had better facilities. However, the layout and interior arrangements of dairy buildings should be planned so that necessary work may be done easily. Obviously the

Table 18. — Distances Traveled in Performing Various Dairy Chores[a]

Operation	Number of farms on which distance traveled (in feet) was—										
	0-25	26-50	51-100	101-150	151-200	201-300	301-500	501-1,000	1,001-2,000	2,001-3,000	Varied
Grain to cows[b]	85	40	135	50	22	10	5	2	0	0	0
Grain to young stock	69	49	132	55	26	11	5	2	0	0	0
Roughage to cows	268	71	10	1	0	0	0	0	0	0	0
Roughage to young stock	242	77	21	4	5	1	0	0	0	0	0
Bedding to cows	208	102	34	3	1	0	2	0	0	0	0
Milking area to milkhouse[c]	87	82	86	52	20	6	2	0	0	0	0
Feed preparation to feeding area for cows	177	83	59	19	7	4	0	0	0	1	0
Feed preparation to feeding area for young stock	168	69	69	21	11	6	5	0	0	1	0
Distance to get cows	163	86	35	14	13	2	33	2	10	1	21
Distance to turn out	116	24	62	44	48	15	3	7	9	3	19

[a] Refers to distance traveled between two points for one operation. If operator returns to starting point by the same route these distances would be doubled.
[b] No grain fed to cows or young stock on one farm.
[c] No milkhouse on 15 farms.

operator who has managed to do well in spite of inconveniences will be even more efficient in a new or remodeled building, the functional arrangement of which has been carefully considered.

Sanitation. Facilities presumed to affect quality of milk are covered in general in Table 17. Not specifically listed but definitely helpful in keeping the herd and barn clean is an impervious platform outside the cow entrance. Concrete or semi-impervious platforms were found on 199 and 33 farms respectively. One hundred and twenty-eight had no provision of this nature.

Table 19 presents a detailed evaluation of some of the cleaning problems covered generally in Table 17.

Table 19. — General Status of Features of Buildings and Other Facilities Related to Cleaning Operations

	Good	Fair	Poor	Total
Building material and construction		(number of farms)		
Stalls	303	14	33	350
Gutters (4 farms without gutters)	312	7	27	346
Alleys	286	22	42	350
Mangers	252	39	59	350
Milkhouse	169	12	154	335[a]
Piped water in barn	198[b]	..	152[b]	350
Piped water in milkhouse	293[b]	..	42[b]	335
Equipment for removing manure	198[c]	29[d]	123[e]	350
Drainage conditions of lots	178	94	78	350

[a] Fifteen had no milkhouse.

[b] "Good" and "Poor" for these items mean piped water was supplied or was not supplied, respectively.

[c] Fifteen of these farms had mechanical cleaners, 91 had litter carriers, and 92 had "drive-in" arrangements.

[d] These farms used a cart or wheelbarrow.

[e] These farms used hand methods only without benefit of cart, wheelbarrow, or "drive-in" arrangements.

One hundred and sixty-one farms had no equipment for cleaning cows such as clippers, hose, washrack, and cart for carrying washing solutions. Clippers alone were used on 117 farms, 61 farms had added a cart, 11 used one of the single items other than clippers.

Facilities for cooling milk were scored primarily according to the type of cooling system and adequacy of the cooling tanks. A tank which could hold the production of one day was considered adequate. Such tanks with refrigeration equipment were found on 106 farms. Tanks alone were found on 143 farms; refrigeration equipment on 38. Fourteen farms had some combination of surface cooler, walk-in refrigerator, and tank of adequate size, while 49 farms had no cooling facilities.

For a clean milkhouse good drainage is essential. Of the 335 milkhouses, 294 had built-in drains; 81, however, were inadequate in size or poorly constructed. On 41 farms there were no provisions for drainage. The drain outlet was at least 100 feet from the milkhouse on 130 farms, but on 132 it emptied just outside the milkhouse wall. For the remaining 32 farms, the drain emptied somewhere between the milkhouse and 100 feet from the wall.

Facilities for washing and sterilizing utensils on 250 farms included hot water, chemicals, brushes, and at least two washing compartments. The first three of these items were found on 60 farms, while one or two were present on 34 farms. Only 6 farms had no facilities for washing and sterilizing utensils.

In scoring utensils the following points were considered: corrosion-proof metal, flush soldered joints, ease of cleaning, and small-mouth pails. Only 33 farms met less than three of these specifications, small-mouth pails being most frequently lacking.

Types of Buildings and Changes Most Desired by Farmers

The type of building influences the functional character of the building, but there is a wider range among characteristics within a given type of building than there is among types. Many of the barns examined in this study were built for other purposes than dairying. Many had undergone changes and were difficult to classify as to type. For example, many arrangements approaching loose housing consisted of a barn with a stall for each cow plus a shed to which cows had access when not in stalls. Such an arrangement is neither a conventional stall barn nor a true loose housing system and lacks many of the advantages of both types.

All but 56 of the farms had some type of stall-barn arrangement. These included: 101 1-row stall barns; 75 2-row stall, face-in barns; 108 2-row stall, face-out barns; and 10 with more than 2 rows of stalls.

Fifty-six farms had provided loose housing for the cows, but many of them had retained stalls for all producing cows. None of these farms could properly be classified as having a complete loose housing system.

Each of the operators of the 350 farms studied was asked a series of questions determined in advance to learn: (1) definite changes planned for the near future and (2) changes not projected but which the farmer would make if he were starting from the beginning. Some of the latter modifications could, no doubt, be accomplished by remodeling, but at the time of this survey these particular farmers were

Table 20. — New or Remodeled Buildings and Other Facilities Planned or Wanted by Farmers Answering Questionnaire

Building or facility	New construction		Remodeling[a]	
	Planned	Wanted but not yet planned	Planned	Wanted but not yet planned
	(number of farmers)			
Dairy barn	12[b]	13[b]	20	59
Milking area	9[c]	26[c]	3	6
Loose housing barn	7[c]	25[c]	5	6
Milkhouse	10	9	4[d]	22[e]
Shed for young stock	3	1	4	1
Hay shed	4	2	3	..
Silo	2	2	..	3[f]
Surface lots or approaches	13	2	..	..
Surface interior	6	1	..	..
Additional equipment	19	19	..	..

[a] Would not involve changes from the existing type of structure.
[b] Not determined whether these would involve basic changes in building type.
[c] Would involve a change from the existing type of structure.
[d] Two of these would involve relocation.
[e] Eighteen of these would involve relocation.
[f] All of these would involve relocation.

not considering remodeling. Two hundred and two farmers responded (Table 20). In addition to the remodeling indicated in the table, major repairs were planned for 17 barns.

The general trend of changes in barns as indicated by answers to the questionnaire was toward loose housing. Although only 56 farmers had any type of loose housing in 1947, 7 farmers planned to construct loose housing barns and 25 wanted such structures although they had no definite plans for building them.

Because of the trend away from loose hay many of the old barn lofts were found to be largely waste space. Loose hay was fed exclusively on only 52 farms in this study, chopped hay on 57, and baled hay on 170. The remaining 70 farms used various combinations of baled, chopped, and loose hay. This general tendency away from loose hay to forms more easily stored makes the use of one-story barns practical.

General structural level, a classification based on material and quality of construction used in buildings, indicates the repairs and new construction that will be needed in the next few years.[1] Dairy barns on 153 farms were of the highest structural level, 177 were intermediate, and 20 were low. The structural level of milkhouses was

[1] For explanation of the classification of dairy barns according to structural level see footnote on page 17.

high in 164 instances, intermediate in 144, and low in 9. On 18 farms the milkhouse was either inside the barn or equipment was cleaned in the residence; 15 farms had no milkhouse.

Condition as well as structural level is indicative of future needs for repairs or new construction (Table 21).

Answers from farmers regarding changes planned or desired revealed a considerable amount of uncertainty as to types of building arrangement and their advantages and disadvantages. Apparently,

Table 21. — General Condition of Principal Dairy Buildings

Part of building	Good		Fair		Poor	
	Barn	Milkhouse	Barn	Milkhouse	Barn	Milkhouse
			(number of farms)			
Foundation	250	265	90	45	10	7
Floor	263	228	69	62	18	27
Walls	194	234	134	74	22	9
Roof	237	247	93	61	20	9

however, farmers were well aware of most of the improvements in crop varieties and in practices in crop and livestock production. Their lack of information on building developments is not hard to understand. Farm buildings once constructed have to be used largely as they stand and their fixed character retards the response of their owners to new ideas, but each year presents a new opportunity for improved cultural practices. In addition farmers do not always have the best information available for planning new or remodeled structures.

Even construction types classified in the lowest group (footnote on page 17) may attain reasonable permanency in the future through new developments in loose housing, for example the use of pole frame structures for cattle shelter.

Farmers in general recognize the importance of certain features in dairy buildings: sufficient space per cow, fresh air without drafts in enclosed buildings, clean, convenient, and adequate storage for feed, a good water supply, equipment for efficient cleaning, and other such sanitary provisions as help insure high-quality milk. Fortunately buildings that provide all these features can be built for less than the cost of many inferior buildings. In this study dairy buildings were as often rated low on farms where the building investment and maintenance cost per dairy animal unit were high as on farms where they were low.

SUGGESTIONS FOR IMPROVING DAIRY BUILDINGS

After a farmer recognizes that his dairy buildings need remodeling or that he should erect new ones, his problem is one of deciding on plans. The two-story barn of expensive materials and permanent construction is not a satisfactory answer for most farmers. Modern engineering offers other solutions which should be considered.

Relative Advantages of Loose Housing and Stall Barns

A loose housing system has the advantages of being very flexible and relatively inexpensive. If the owner wishes to work alone he can care for a larger herd than is ordinarily possible with a conventional stall barn, providing, of course, that the system is well-arranged. When need arises, he can readily convert from dairying to other types of livestock enterprises. Since loose housing is less expensive than most stall barns, many farmers who could not otherwise afford the initial expense of starting a dairy business, can build a loose housing system.

Manure can be handled more simply in a loose housing system than in a conventional stall barn, and because much of it is protected from the weather, its fertility value will be high. It can be removed with a tractor-mounted power lift at a lower cost than can be attained in a stall barn with either hand labor or power equipment. It can be taken from the barn to the fields a few times each year, usually at the convenience of the operator.

Loose housing has other advantages such as: simpler sanitation in the milking area, better herd health, a longer productive life for the cows, and less possibility of loss of animals by fire.[1]

Although the health of the animals is benefited by the open nature of loose housing, the operator will be uncomfortable in cold weather unless heaters are installed in the milking area and in the milkroom. In the stall barn, however, the cow area when closed is usually warm enough for the operator, but some dependable provision for ventilation will be necessary to control humidity and prevent too high a temperature in hot weather.

Usually about 20 percent more bedding has been used with loose housing than with the stall barn. In areas where there is a shortage of crop byproducts, this becomes a problem. However, with best

[1] For a more complete discussion of the merits of loose housing, see U. S. Dept. Agr. Information Bul. 98, "Loose Housing for Dairy Cattle," and Illinois Circular 694, "Loose Housing for the Farm Dairy." The first is available on request from the U. S. Department of Agriculture; the second from the College of Agriculture, University of Illinois, Urbana, Illinois.

arrangement and good management the bedding requirements may be little more or even less than for stall barns.

A frequent criticism of loose housing is that cows do not have time to eat their grain. However, experience has shown that cows will speed up their rate of eating grain when time is limited. One efficient operator using two bucket-type machines in milking room arrangements such as shown in Fig. 22 can milk 25 to 30 cows per hour. The cows would then have 6 to 8 minutes for eating grain, time considered adequate by many herdsmen. If more time is desired, the order of milking operations can be changed or an extra stall be added to the milking room.

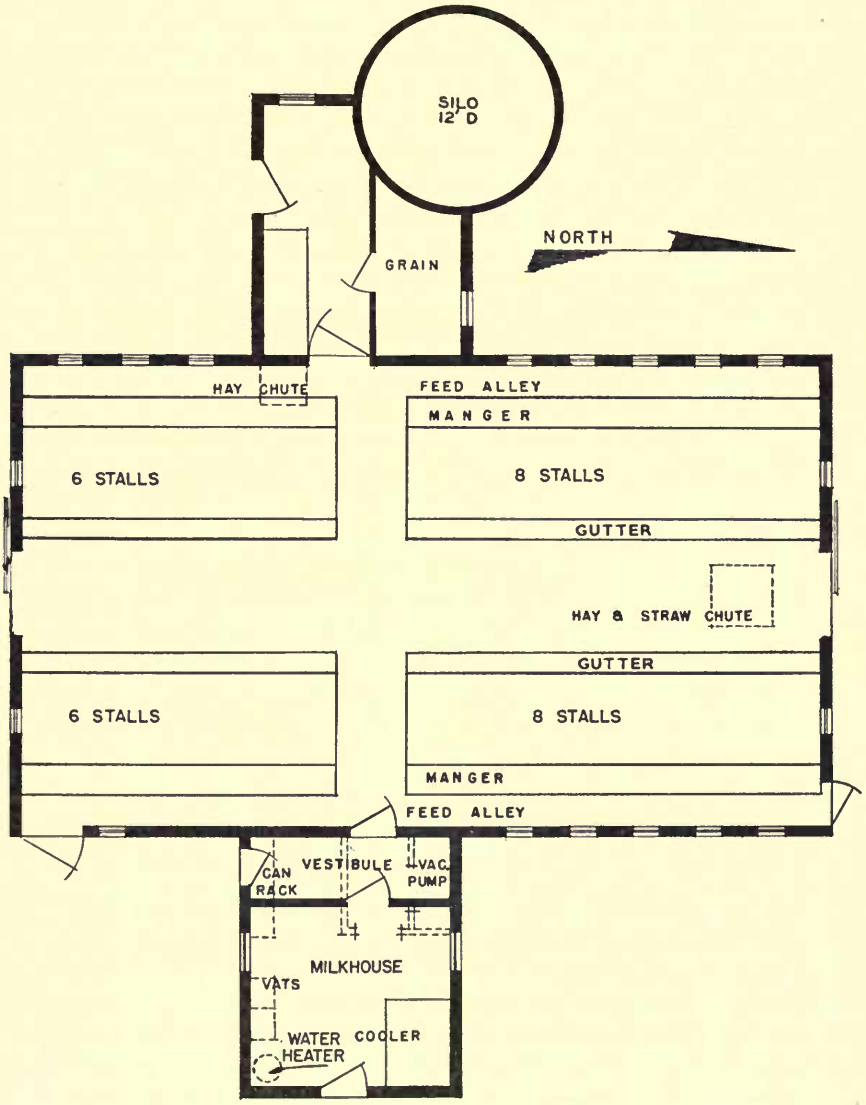
There are some dairymen whose needs are best suited by stall barns. Those with purebred cattle sometimes prefer to keep their cows in stanchions for convenience in showing them to prospective buyers. Owners who are interested in their cows as "show animals" do not want to dehorn them. In a loose housing system dehorning is most desirable and usually necessary to prevent injuries.

When remodeling a stall barn to comply with Grade A milk regulations, the owner may find retaining the conventional system more economical. Before deciding to change, he should consider the condition of the permanent features, the cost of changing them, the general layout, and the availability of the additional ground space needed for loose housing. If a stall barn is preferred, it may be a one-story structure. One-story plans are suitable for loose housing or stall barns if there is adequate space in the farmstead. (See Figs. 20 and 21.)

Three specific cases were selected from the farms surveyed for detailed study and illustration: a good stall barn, a poor stall barn, and a remodeled loose housing system. The text and the accompanying illustrations show the good and bad points of each. Possible improvements are also indicated. To supplement these actual cases, two plans, one for a one-story stall barn and one for a loose housing system, are also illustrated and discussed.

A Good Stall Barn

One of the best stall barn arrangements observed in this survey is that shown in Fig. 14. Good features include: (1) feed storages conveniently located nearly in the center of the barn on one side and overhead in the loft; (2) a milkhouse conveniently located almost in the center of the opposite side; (3) a center cross alley well placed with reference to the feed storage, the stall area, and the milkhouse; (4) room for more labor-saving equipment such as a gutter cleaner and silo unloader if desired.



A good stall barn for 28 cows. Cross alleys and central location of milkhouse and feed room permit efficient operation. Improvements could be made by adding straw and hay chutes and by changing the milkhouse arrangement as shown by dotted lines. (Fig. 14)

Minor improvements suggested. Changes could be made which would improve this building. (1) An additional cross alley at the north end of the barn could save as much as 15 percent of the travel necessary for feeding, but the operator would have to decide whether the loss of two stalls (where the cross alley would be located) would be offset by greater efficiency in feeding. (2) For a minimum of travel for hay feeding there should be at least one, and preferably two, hay chutes properly spaced above each feed alley. (3) Moving the present straw chute to the center of the north litter alley and adding another in the middle of the south alley would greatly facilitate the handling of bedding.

If convenient space for calves and heifers is desired, the dairy barn itself might be extended. Pens at either end of the stall area would be satisfactory and convenient. Attaching another structure to one side or to the end would decrease the window space in the dairy barn and make feeding and caring for young stock more difficult.

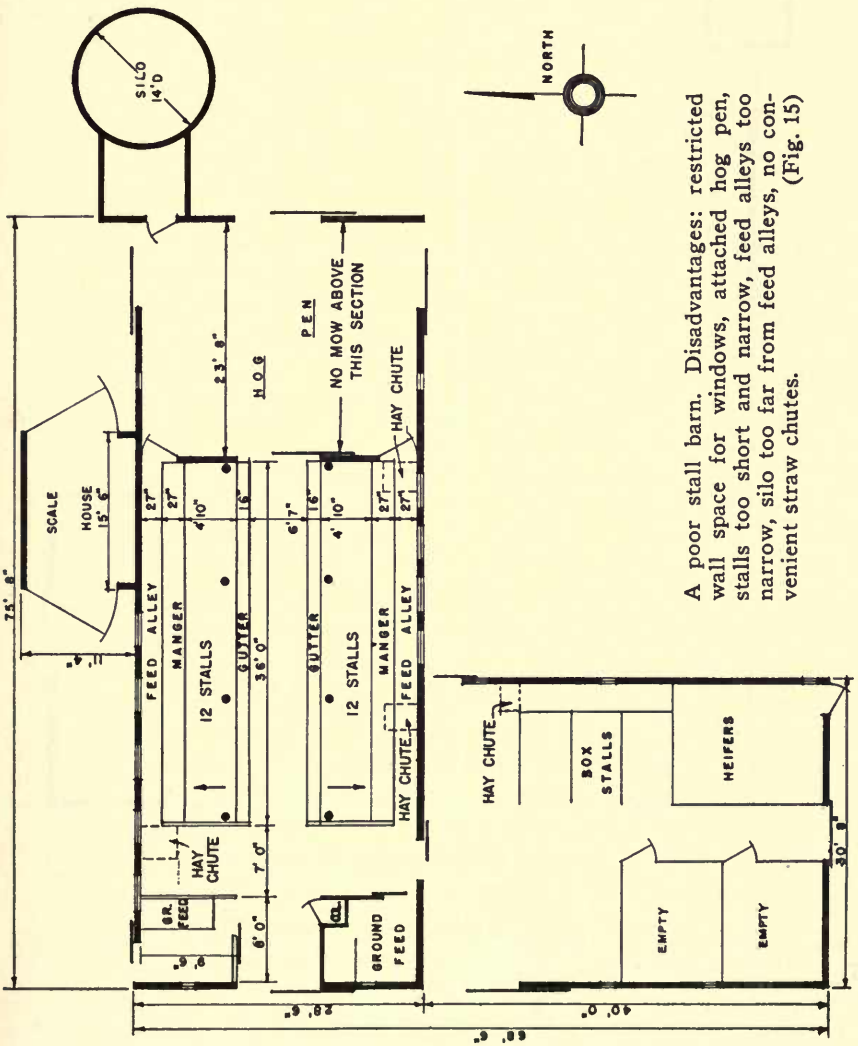
Some changes would be needed if the milkroom were to be made to comply with Illinois Grade A milk regulations. These require a distance of 6 feet between vestibule doors and here there are only 4 feet. To improve the milkhouse the outside vestibule door should be eliminated and the vestibule arranged as indicated by the dotted lines in Fig. 14. It would also be desirable to add a window in the east wall of the milkroom and to rearrange the water heater, vats, and can rack to conform to the change in location of the inner wall. Estimates of the cost of making these improvements are presented later in this section.

A Poor Stall Barn

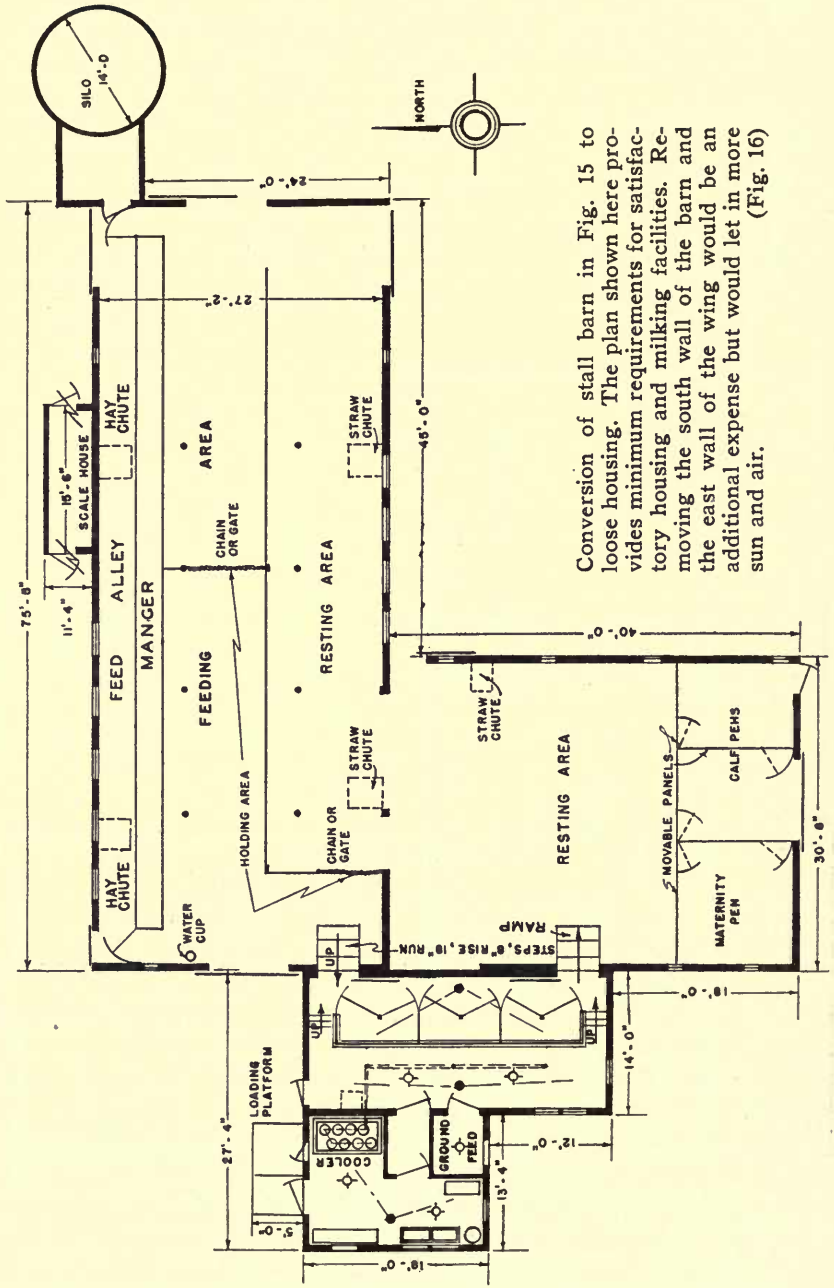
The layout of another stall barn found in this study is illustrated in Fig. 15. This is in many ways a poorly arranged building, neither well-lighted nor convenient.

The long axis runs east and west, resulting in less sunlight than if the axis ran north and south. Natural lighting is reduced by the three attached buildings (scale house, hog shelter, and south wing) that cover one-half the perimeter of the dairy barn. Although the window area is almost adequate, this arrangement prevents an even distribution of light.

The outside barn width of 28½ feet is about 8 feet too narrow for a drive-through arrangement. Stalls are only 3 feet wide, whereas they should be 3 feet 6 inches or more. The cross alley width is 7 feet although 4 feet would have been ample. The litter and the feed alleys



A poor stall barn. Disadvantages: restricted wall space for windows, attached hog pen, stalls too short and narrow, feed alleys too narrow, silo too far from feed alleys, no convenient straw chutes. (Fig. 15)



Conversion of stall barn in Fig. 15 to loose housing. The plan shown here provides minimum requirements for satisfactory housing and milking facilities. Removing the south wall of the barn and the east wall of the wing would be an additional expense but would let in more sun and air. (Fig. 16)

are too narrow; the latter will not permit the use of a feed cart. Hay chutes are not conveniently located. When straw is stored in the loft it must be dropped through a hay chute.

Travel distances are excessive. The milkhouse is 30 feet west of the south wing. The silo is too far from the feeding area and the silage can be brought only to the end of the feed alleys with the feed cart.

The various areas of the building are not well assigned. The south wing is not used to fullest advantage. The pens in the west end of the building are better suited for small calves but are used instead for miscellaneous purposes. Part of the area adjacent to the east end of the stalls is used for hogs.

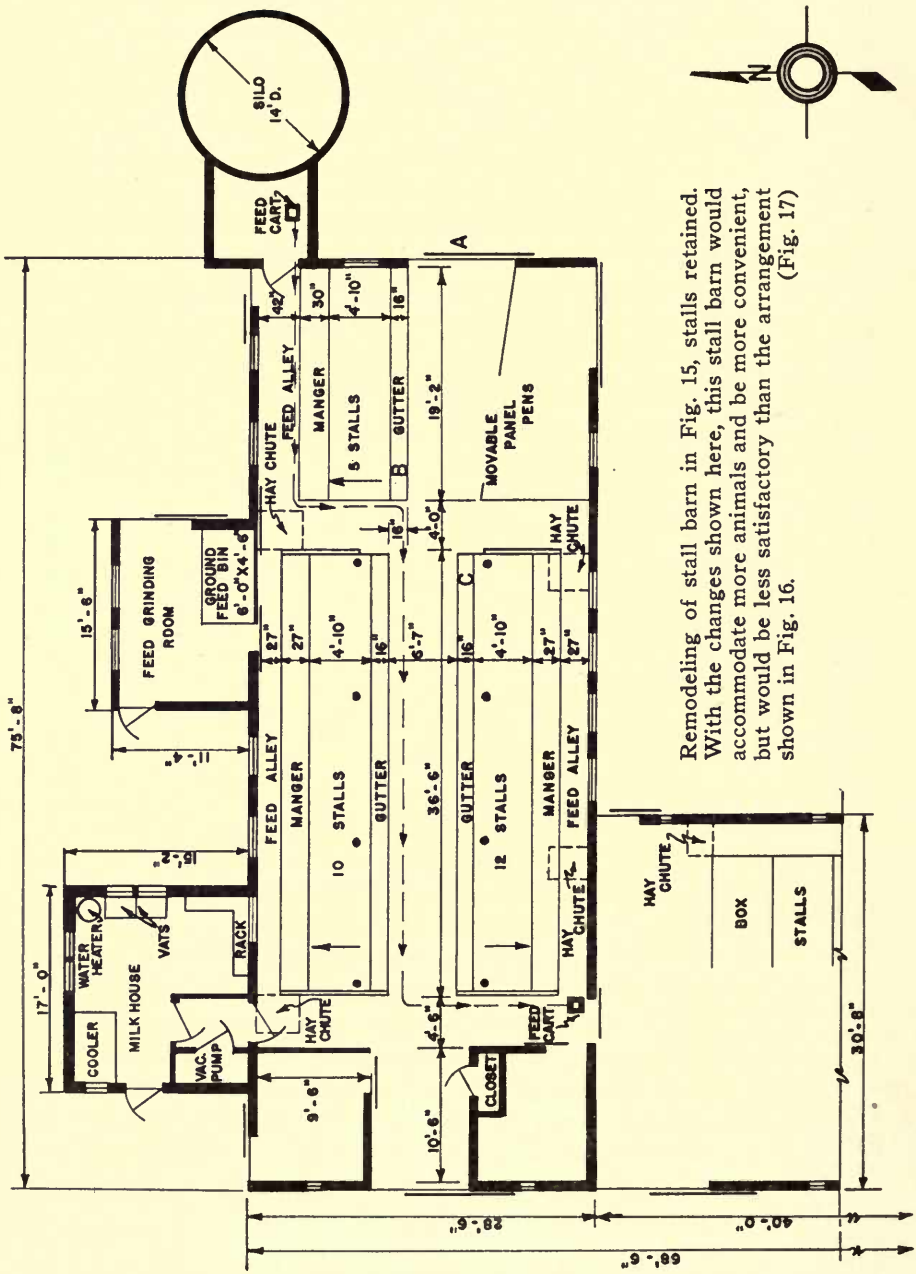
Remodeling suggestions. This barn might be remodeled as a stall barn or converted into a loose housing system. The latter would be the more feasible and less expensive way of improving the arrangement of the work areas and saving labor in the handling of the herd. In Fig. 16 the necessary changes are shown. They include:

1. Removing stalls, mangers, and also the pens at the west end, the wall between the stall area and the hog pen on the east end, and part of the wall common to the south wing; filling in gutters, and changing the pens and stalls in the south wing;
2. Widening some doors to accommodate a tractor and manure spreader;
3. Adding a hay chute to the feeding area;
4. Adding a complete three-in-line[1] tandem milking plant to the west end.

The second alternative of improving the existing structure for continued use as a stall barn would leave much to be desired, but it is presented here for purposes of comparison (Fig. 17). The principal difficulty is the narrowness of the barn, which reduces the alley width and leaves the stalls too short for large cows. The center alley might be cut to 6 feet to allow for longer stalls.

Major changes in the barn shown in Fig. 15 would provide for three more cows and increase the size of the stalls on the north side, those on the south being kept for heifers and small cows. The 12 stalls on the north would be reduced to 10, but 5 new stalls would be added

[1] For purposes of illustration, three-in-line tandem milking plants were added to the loose housing systems shown in Figs. 16 and 21. Alternative milking room arrangements as shown in Fig. 22, page 62, may be selected to fit the size of herd, general building arrangement, and preferences of the operator.



Remodeling of stall barn in Fig. 15, stalls retained. With the changes shown here, this stall barn would accommodate more animals and be more convenient, but would be less satisfactory than the arrangement shown in Fig. 16. (Fig. 17)

by converting part of the space now used by hogs into an additional cow stall area. The remainder of this space would be used for calf or maternity pens with movable panels. The hogs would be moved to the old attached south wing where they could be fed on the paved area south of the barn. The present scale house would be used for feed grinding and storage of ground feed. The milkhouse would be moved and attached to the north side of the barn or a new one built as shown in Fig. 17. A more central location would be preferable, but would involve moving the scale house.

One of the minor changes would be widening the door at point A by 2 feet so that the spreader could be backed into the barn through the door and an overhead litter carrier be used for cleaning. A cross alley 4 feet wide should be left between the old and new stall sections to permit use of a silage cart. The cross alley at the west end should be reduced to 4½ feet in width to permit enlargement of the pens in the west end. These would then be of ample size for use as maternity or calf pens. Another hay chute should be provided on the north side.

More windows should be added in the north wall of the east end section.

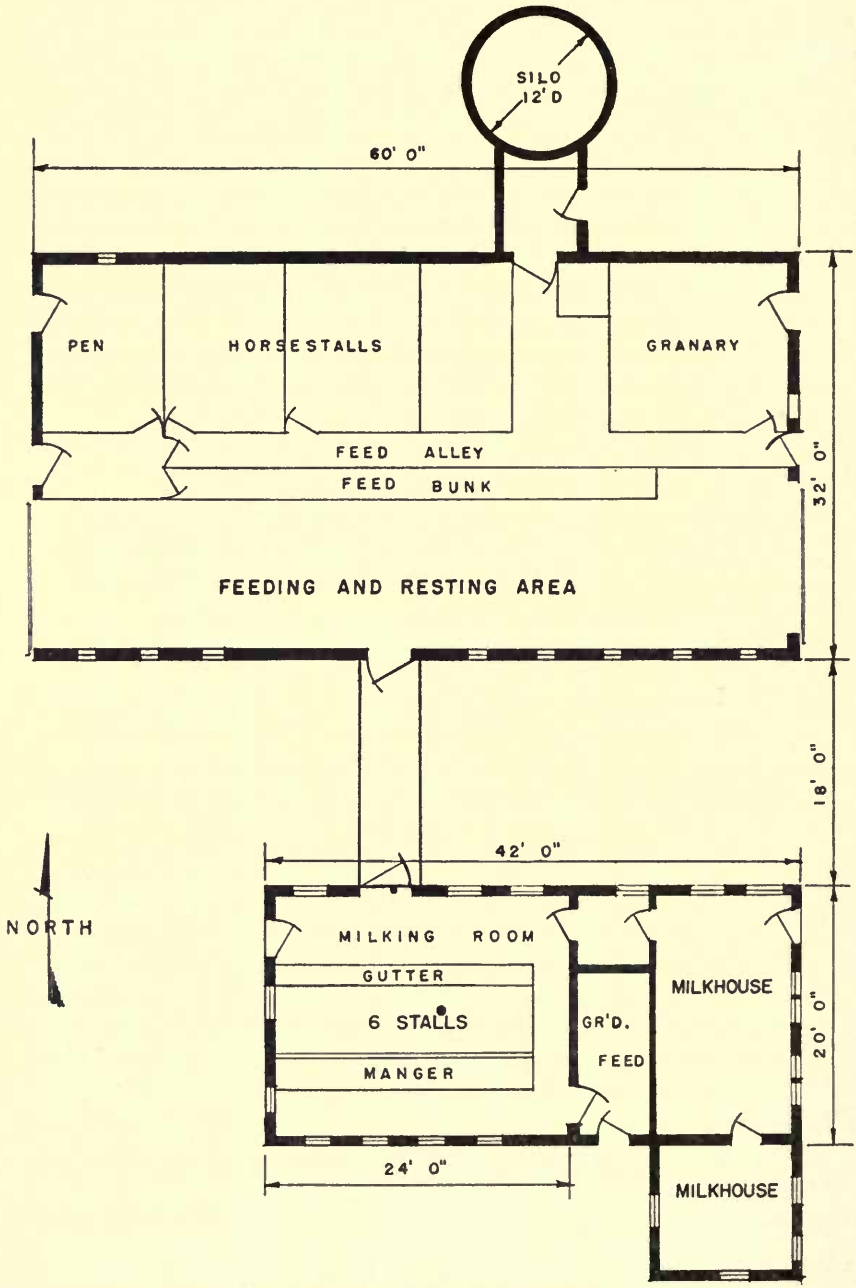
Remodeling to Improve Loose Housing

None of the loose housing observed on the farms in this survey was newly constructed. That found consisted of sheds or areas for feeding roughage and for bedding while a part or all of the original barn was retained for use as a milking room. One farm was selected from the survey to illustrate the results of inadequate planning (Fig. 18).[1]

In remodeling this barn the owner kept costs low largely by limiting new construction to a milking room and milkhouse. For no more than he spent, perhaps for less, he could have built a milking room with fewer stalls, such as shown in Fig. 19, more conveniently located with reference to the feeding and resting area.[2] In this elevated stall type, one operator with two bucket-type machines can milk 25 to 30 cows per hour more easily and with less travel than in the abreast type (Fig. 18) in which the maximum rate of milking is 18 to 20 cows per hour. Such an arrangement would have reduced the owner's direct

[1] A second milkroom such as shown in Fig. 18 is not required by the Illinois Grade A law unless raw milk is to be sold for fluid consumption.

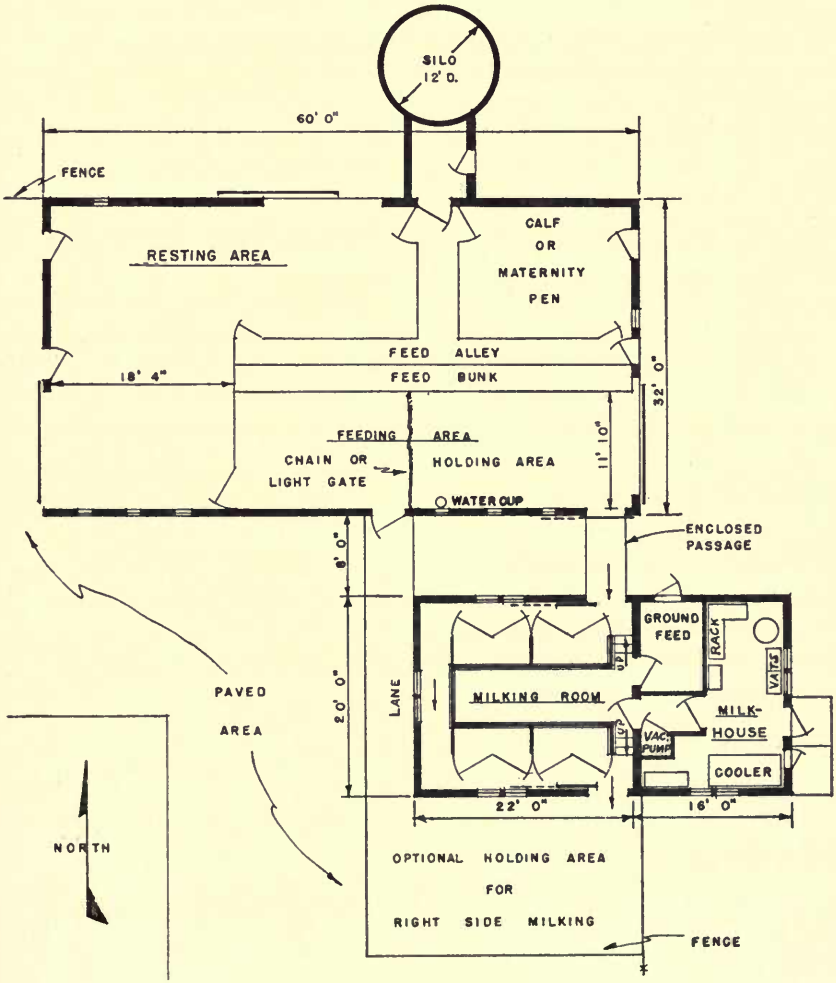
[2] The U-tandem 4-stall arrangement was selected rather than the in-line tandem because it fitted the space available and also the particular arrangement of the milking area.



This loose housing plan is only partly satisfactory. It could be improved by separating the resting area from the feeding area, using elevated stalls, and making the milkhouse smaller. (Fig. 18)

and indirect operating costs. It would not, however, be economical for him to change now.

Certain improvements in the resting and feeding areas could still be made economically. The horse stalls and granary could be removed, freeing this space for calves, a maternity pen, and for a resting area.



Further improvements for the loose housing arrangement of Fig. 18. The elevated-stall milking room and milkhouse shown here would cost less and be more convenient. Steps or a ramp should be built in the enclosed passage at the cow entrance and a ramp at the exit. (Fig. 19)

In any case, the resting area should be separated from the feeding area. This could be accomplished by means of a gate or movable panel, an open passage being left between the two areas so that the cows can move freely between them at all times. Moving the feed bunk to the east wall would provide some resting area in the space now occupied by and adjacent to the west end of the bunk. A 10-foot sliding door on the north side of the resting area would make removing the manure easier. These changes would provide 50 square feet of resting area per cow, sufficient for loose housing, and at the same time reduce chore labor substantially (Table 22).

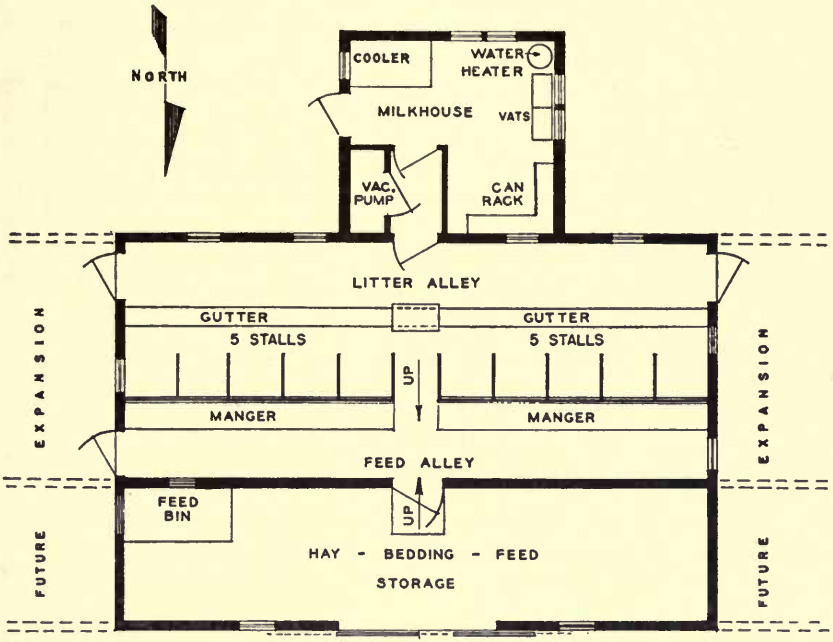
The floor of the resting area should have at least an 8-inch fill of well-tamped earth. The feeding area should be paved to permit cleaning with a tractor and scraper blade. A water cup should be installed in the feeding area in the south wall as indicated in Fig. 19.

Had the barn been remodeled as indicated in Fig. 19, the cows would have entered the milking area in a way that would have required them to be milked from the left side. Many cows in stall barns are accustomed to this position, and all can be trained for it. But if right-hand milking is preferred, a holding pen can be built adjacent to the south side of the milking room. The cows would then go through the milking room in the opposite direction and be milked from the right.

Plan for a One-Story Stall Barn

One-story stall barns can be built and operated at less cost than many of the two-story barns commonly found. They are less expensive to build because they do not need extra bracing and flooring to support overhead storage. In a time-and-travel study of a two-story barn, two efficient operators worked full time to milk 22.8 cows an hour. A well-arranged one-story stall barn, with labor-saving equipment impossible in the old barn, was built nearby. In the new barn one of the original operators was able to milk the same herd at the rate of 20.6 cows per hour with less effort. Thus nearly half the labor cost was saved. The old barn was continued in use for storage of feed and bedding and for calf and maternity pens.

A good, low-cost, one-story stall barn for 10 cows is illustrated in Fig. 20. In most instances, a one-story barn will be more functional and more easily enlarged than a two-story barn. In the one shown in Fig. 20 the work areas are conveniently located. Feed and bedding storage begins at the ground level. The one-slope roof slants toward the milkroom and rain water is carried away from the open lot. As



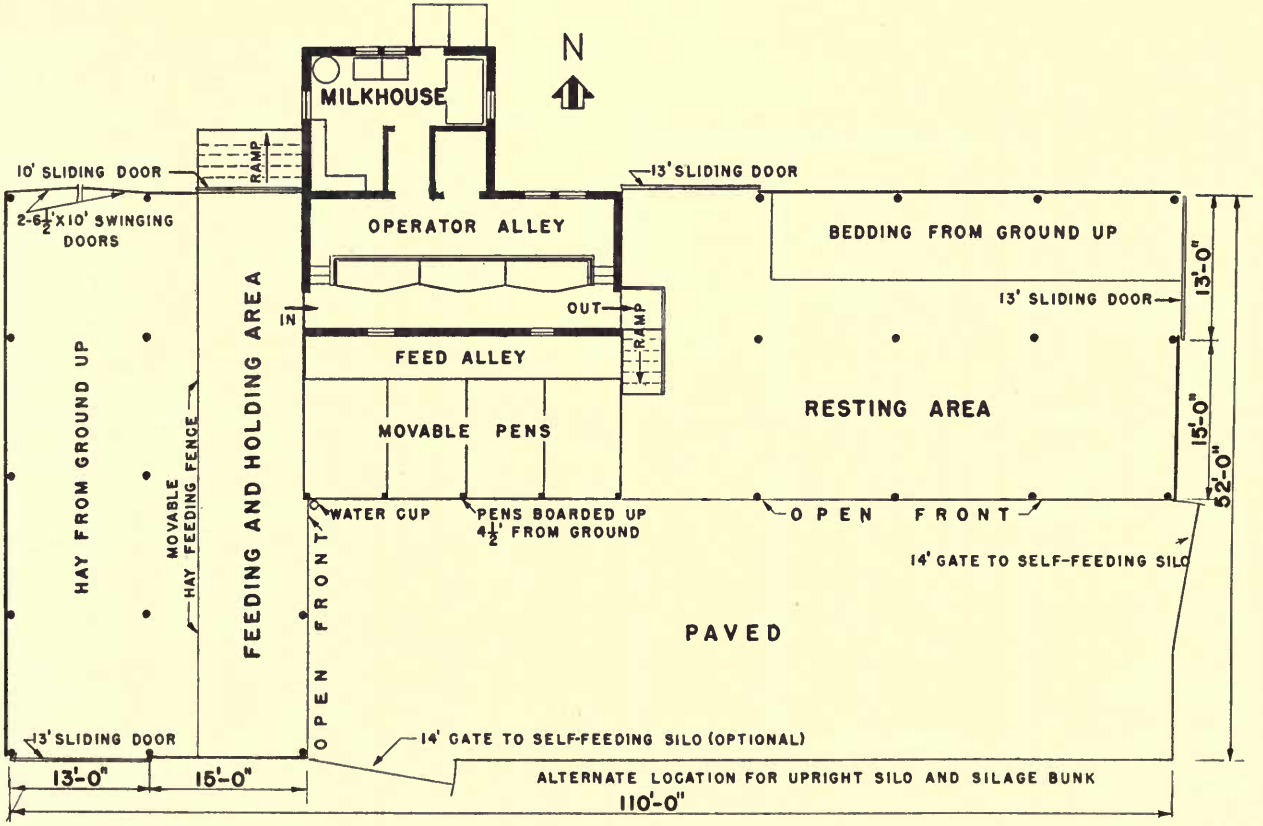
A one-story small stall barn, that can be expanded to 20 stalls. (Fig. 20)

the herd increases, four or five stalls may be added as needed to either end without lowering the efficiency of the arrangement appreciably. But if eight or ten stalls are added, an equal number should be placed at each end to keep the milkhouse centrally located.

Plan for a One-Operator Loose Housing Dairy

None of the 350 farmers studied had a complete loose housing system, but many of them were interested in building one later. The arrangement illustrated in Fig. 21 was chosen because it combines many of the features it would be desirable for these farmers to have and because it is economical and functional.

The plan as shown is for one operator, two bucket-type machines or three machines with piped milk, and a herd of 25 to 30 cows. For larger herds a second operator and more machines can be added and a U-shaped milking room with four or five stalls can be substituted for the three-in-line type shown. A U-shaped milking room also could be placed between the two wings of this dairy plant instead of being located as shown in Fig. 21.



One-story loose housing plan for a herd of 30 to 35 cows. By modifying the size of the feeding and resting areas, this plan may be adapted to herds of 15 to 50 cows. (Fig. 21)

This is a one-story dairy plant with all feed storage on the ground. The roof of each wing slopes away from the open lot. That part of the lot adjacent to the feeding and resting areas, the feeding area, and the feed alleys should be paved, but other pavement is optional. Six to 8 inches of well-packed earth is sufficient fill in the resting area. Some prefer putting an inch or two of crushed limestone on top of this fill.

In the feeding area the floor slopes upward from grade level at the end near the water cup to 22 inches above grade level at the milking-room entrance. This slope takes the place of a ramp from the feeding area to the milking room which is 30 inches above the grade level. Without the obstruction of a concrete ramp the feeding area can be more easily cleaned with a tractor and scraper blade. The cows step up 8 inches from the feeding area into the milking room. A ramp is provided for the cow exit from the milking room into the resting area.

If more calf and maternity pens are needed, the feeding-area wing can be extended. The calf and maternity pens have movable panels to allow for expansion and for removal of manure with power equipment.

Chore Time and Travel Under Different Arrangements

The work habits of the operator, his rate of walking, the way he plans to avoid unnecessary steps, and the various minor devices he uses often have the greatest effect in making chore labor efficient. The relative merits of different arrangements with respect to their effect on chore-labor efficiency may be determined by showing distances that would have to be traveled by a worker following stated work habits (Table 22). There would, of course, be a wide range in the time required by different operators working with the same arrangements.

Estimated Construction and Remodeling Costs

In estimating the outlay necessary for building or remodeling a given dairy building, definite assumptions were made as to price levels, the kind and quality of materials used, the general level of construction, the extent to which hired labor would be employed, the speed of the workers, the wage rate, and other items. Since many of these circumstances are certain to be different when any of these structures are actually built, the final cost may vary as much as 30 percent from these estimated costs. Estimates such as these are useful as indicators of the relative costs of different arrangements, not as guides to be followed literally by the man who wants to build.

Table 22. — Estimated Travel of Operator for Specified Chores

Structure	Fig. No.	Number of cows	Operator travel per milking, feet per cow							
			Feeding			Milking operations	Carrying milk (bucket machines)	Washing udder	Admitting and releasing cows	Total[a]
			Silage	Baled hay	Grain					
Good stall barn, before remodeling	14	28	11	23[b]	10	29	77	16	19	185
Poorly arranged stall barn	15	24	35[c]	22[d]	17	28	186 or 93[e]	14	11	313
Fig. 15 remodeled for loose housing	16	27	9	13	9	23	42	11	6	113
Fig. 15 remodeled as stall barn	17	27	30	12	17	26	88	15	13	201
Poor loose housing arrangement	18	17	10	13	12	39	56	22	37	189
Poor loose housing remodeled to better loose housing	19	17	9	11	8	18	42	8	6	102
One story, 10-stall barn	20	10	([f])	18	8	28	50	15	22	141
Good loose housing arrangement, new construction	21	25	9	6	9	23	42	11	6	106

[a] Total travel does not include miscellaneous chores such as calf feeding, preparation and cleanup, putting cows in holding pen, or travel between certain work areas such as from feeding and bedded areas to milking area.

[b] With a second chute (as suggested for remodeling) travel for feeding hay can be reduced to 18 feet per cow.

[c] Feed alley too narrow for commercial feed cart. Silage was carried by hand in baskets. It is assumed that one basket fed three cows.

[d] Three chutes were available but frequently only one was used. Distances presume use of the northwest and southeast chutes.

[e] Depending on whether one or two cows per trip.

[f] This plan does not include a silo.

All of the estimates given here are limited to those types of construction commonly considered permanent. In practice, however, the farmer is not limited to any one level of construction. He may use farm-produced timber rather than depend on the lumberyard. He may prefer treated poles with frame construction to stud-wall framing and concrete foundation, or pole frame to masonry when constructing the roughage feeding or resting areas for the cows. He may sacrifice some permanence in order to lower his costs.

The estimates in Table 23 relate specifically to the arrangements shown in Figs. 14 to 21. They are presented on a per-cow basis and are as economical as possible, granting reasonable permanence and the assumptions already stated. As these estimates include hired labor and purchased materials, the cash cost of any structure could be reduced to the extent unpaid family labor or farm materials were substituted.

Costs of new construction (Figs. 20 and 21) may be compared with the estimated average costs of reconstructing existing dairy buildings presented on pages 8 to 11. Before comparing, it is necessary to add to these estimates the cost of facilities for young stock and the proportion of additional grain storage and water system that may properly be charged to the dairy enterprise.

For the 10-cow stall barn the additional grain storage, based on consumption of 25 bushels of corn per cow, would cost about $200, if cost of the storage structure is $.80 per bushel. Normally about 70

Table 23. — Estimated Costs of Constructing or Remodeling Selected Dairy Buildings at 1947 Prices
(Including milking and milk-handling areas)

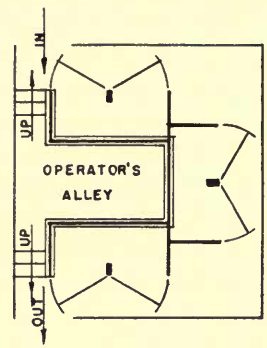
Building		Number of cows	Approximate cost of materials and labor[a]	
Description	Fig. number		Total	Per cow
Good stall barn with silo				
Reproducing new[b]	14	28	$11,710	$418
Remodeling	14	28	105	4
Remodeling a stall barn for loose housing	16	27	1,930	71
Remodeling a stall barn, stalls retained	17	27	1,030	38
Remodeling loose housing	19	17	2,370	139
One-story 10-stall barn, new construction[c]	20	10	3,720	372
Suggested loose housing system with silo,[b] new construction	21	30[d]	8,010	267

[a] Estimated labor cost is 60 percent of material cost for new construction but is usually a higher proportion for remodeling. Labor costs in this table were supplied by a contractor and are probably appreciably higher than those used in estimating the reproduction cost of buildings earlier in this report.

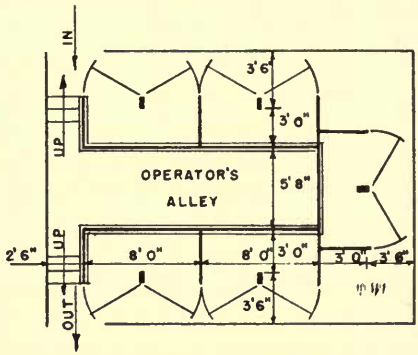
[b] Includes upright silo, estimated cost $1,340.

[c] If the herd is increased to 15 cows or more a silo might be included.

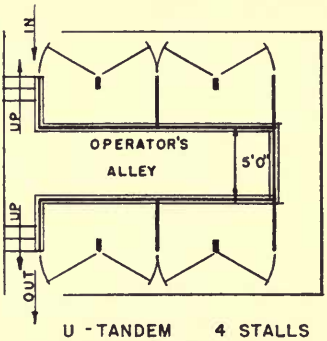
[d] This allows 50 square feet per cow in the resting area, which with good arrangements and management is adequate for Illinois.



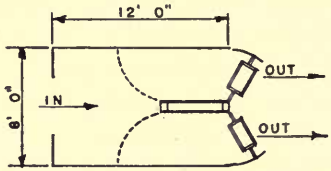
U-TANDEM 3 STALLS



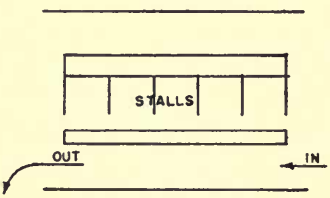
U-TANDEM 5 STALLS



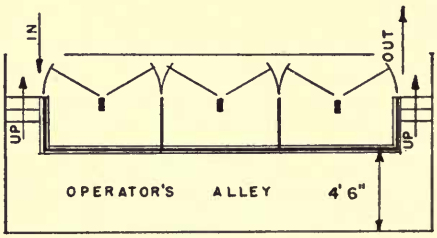
U-TANDEM 4 STALLS



WALK-THROUGH



ABREAST



IN-LINE TANDEM

Types of milking stalls used with loose housing systems. A variation of the walk-through type may have 2 or more elevated stalls in tandem on each side of an operator alley. (Fig. 22)

percent of the dairy-animal units in the herd are producing cows, so that in a 10-cow herd there would be about 4 additional units of young stock. It is estimated that adequate housing for these animals could be built for no more than $50 per unit, making a total of $200, and the proportion of the investment in the water systems chargeable to a herd of this size would be about $100. Thus the total cost of buildings to accommodate a herd of 14 dairy animal units using this stall barn system would be about $4,220 or $302 per dairy animal unit, equivalent to an over-all initial investment of about $422 per mature cow.

The 30-cow loose housing system (Fig. 21) includes space for about 11 units of young stock. A herd of this size would normally have 2 more units of young stock for which an additional $100 would be required. Other additional investments would be about $600 for grain storage and $300 for the water system. The total initial investment for the 43 animal units would then be about $9,470 or $220 per dairy animal unit. This would be equivalent to an over-all initial investment of about $316 per mature cow.

These estimates of the initial investment required for a 10-cow stall barn and a 30-cow loose-housing dairy represent a higher cash outlay than most farmers would have to make. Many farmers could use farm timber and family labor or hired labor at lower rates than those estimated.

The estimated initial investment per dairy-animal unit of $302 for the stall barn system and $220 for the loose housing system are substantially lower than the average reproduction cost of the farm dairies found on farms included in this study. These were $350 in the Chicago area and $372 in the St. Louis, or from $500 to $552 per mature cow.

SUMMARY

A survey was made of 350 dairy farms in the Illinois portion of the Chicago and St. Louis dairy areas to examine the economic and functional characteristics of their dairy buildings.

Investments chargeable to the dairy enterprise on these farms totaled 3.8 million dollars, slightly less than one-half of the amount being in dairy buildings. Cost of replacing these buildings at 1947 prices for labor and building materials would average more than $500 per cow; $300 to $400 would be invested in buildings for each $100 in dairy stock.

There was little difference between unit building investments on farms with large herds and those with small. Few buildings were flexible enough to allow economical changes or expansion.

Functional ratings revealed that low-cost buildings were as likely to provide good service as high-cost buildings. Well-planned buildings of a flexible nature were the most useful in whatever cost range they fell.

Nearly half the variation in functional ratings of buildings was associated with size of herd, age, and structural level of buildings. In general, those operators producing Grade A milk maintained more efficient buildings than those producing lower grades of milk.

Annual dairy building costs represented 8 percent of cash and 10 percent of total dairy costs. They averaged $26 per dairy-animal unit, but varied widely, ranging from a low of $3.32 to nearly $80 per dairy-animal unit.

Although building costs amounted to only 10 percent of total dairy costs, the influence of buildings on labor efficiency, productivity of the herd, and quality of milk must also be considered.

About $300 return per dairy-animal unit was needed to cover all costs, including buildings. There was little difference in unit building costs between farms with $200 return per dairy-animal unit and those with $500.

Efficiency ratings of management could not be developed in this study, but the inventory that was made of management practices showed that improvement was most needed in sanitation and use of labor. Lack of equipment and facilities and poorly arranged buildings were largely responsible for high labor loads and inadequate results. Less than a third of the operators kept records which would enable them to feed according to production. Quality of concentrate rations, management of pastures, and breeding for higher production could also be improved.

Although most of the farmers interviewed had stall barns, they were interested in loose housing. Loose housing would be more serviceable, less expensive, and easier to adapt to changing needs than their present structures.

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