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A Field Study of Practice in Loose Housing of Dairy Cattle in Missouri

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INTRODUCTION

There is need for study of all phases of the problems relating to farm structures and their place in modern agricultural production. The cost of building material and labor has risen sharply since World War II. The depression of the thirties left the agricultural economy over-loaded with obsolete and unsatisfactory structures which could not be replaced during World War II due to unavailability of materials and labor. The technological improvements in farm production which have been achieved in the past decades have not extended in great measure to the field of farm structures.

The cost of dairy structures can perhaps be more easily justified than that of many other types of farm buildings, since the regular income realized from production of high-quality milk cannot be obtained without the use of an approved building in which to milk the cows and handle the milk. Consequently many new dairy structures have been built in recent years. But their construction has in many cases been affected by old practices and neighborhood custom, with little regard for basic fundamentals of good construction and efficient arrangement. A primary cause of this is lack of knowledge concerning the building practices which offer the most advantage from the viewpoints of economy and efficiency.

Farm dairy buildings house a major industry in the state of Missouri. The federal census of 1940 lists the number of cows and heifers milked in Missouri at 822,874. These animals produced 331,573,347 gallons of milk in that year. Production and number of cows are much greater at the present time.

In producing these valuable milk products, the dairy farmer is faced with a number of problems with respect to his physical plant.

A Field Study of Practice in Loose Housing of Dairy Cattle in Missouri*

R. E. STEWART

PART I.—FARM DAIRY BUILDING PROBLEMS

A. High Cost of Construction

One aspect of the dairy farmer's building problem is high cost of construction. Building material and labor costs of the post-war years necessitate careful planning so that undue burden of debt may not be placed against the farm and its dairy enterprise. Ashby (1) wrote in 1949 that farm building costs were then at least twice pre-war. Dairy buildings costing from \$2.50 to \$5.00 per square foot of floor area were not uncommon. However, farm prices were high and farmers generally were in sound financial condition. Use of family labor offset high labor costs.

It may be that the high cost of construction is more apparent than real. It has been observed, however, that the question of high cost has often proved to be a major deterrent to those desiring to undertake construction and remodeling.

B. Public Health Structural Requirements

The design of dairy structures is governed to a large extent by public health regulations. The primary aim of the regulations affecting design and construction of farm dairy buildings is to reduce the contamination of milk intended for public consumption. The "Grade A" designation for a producer may depend quite largely on how his dairy buildings are constructed and maintained.

The basic suggested requirements with respect to the design of farm dairy buildings are found in the "Milk Ordinance and Code", recommended by the United States Public Health Service (24).

1. **Need for Uniform Interpretation.** Where the code has been adopted there still exist certain variations in the interpretation of it by milk inspectors and sanitary officials. Small differences in interpretation of the code's structural provisions often cause extra expense and trouble when a producer desires to change from one market to another.

This problem is further complicated when one considers that a city such as St. Louis may draw its milk supply from two or three different states, each with divergent views as to suitable dairy barn construction.

Where producers live in overlapping milk-sheds, much confusion regarding proper construction can be eliminated by building to the strictest standards which may prevail. This practice may lead to higher costs. A

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need exists for building plans coordinated with uniform interpretation, to make it possible for the producer to meet the public health structural requirements of any market.

2. **Limitation of Pioneering.** Another effect of the public health structural requirements on dairy building design is to limit pioneering of new and improved designs. Since the authorities and their local inspectors are more familiar with the older types of buildings they cannot approve a new type unless assured that it complies with the milk ordinance and code. This tends to discourage rapid adoption of new types of dairy buildings which may have merit.

The producer with new ideas to save labor and construction costs may feel that his efforts to obtain increased efficiency at lower costs are unwanted.

C. High Labor Requirement

Another serious problem confronting the dairy farmer which directly involves the dairy structures is the amount of labor necessary to produce milk of commercial quantity and quality on the average-size dairy farm.

Many farmers avoid the dairy enterprise because it demands such a considerable amount of repetitive chore labor. The reduction of time and effort spent in farm production of high-quality milk is an evident necessity.

The labor requirement of the dairy enterprise can depend to a great extent on the functional design of the dairy buildings. The time and energy necessary for the accomplishment of milking, herding, feeding, bedding, cleaning up, and handling milk may depend to an important degree on the manner in which the buildings are located, constructed, and arranged.

D. Uncertain Factors Concerning Loose Housing

Loose housing is a system which permits the use of any type of barn or shed for shelter purposes, and includes separate facilities for milking.

The loose housing system usually has the following component parts:

a. A loafing barn with space for the cows and the hay and bedding needed for one season. Sometimes the hay and bedding may be stored elsewhere than in the loafing barn or shed. The loafing space is provided for resting, sleeping, and, in some cases, roughage feeding. It also functions as a shelter for the cows. The loafing space is sometimes called loafing area or bedded area.

b. A milking room or milking barn. This is provided for milking the cows and feeding concentrates at milking time, if desired. It is used for no other purposes. A milk-house, or milk-handling room, is usually connected to the milking room. The milking room and milking room-milking barn combination is sometimes called milking parlor.

Types of loafing barns in common use may vary from a small shed, merely a roof and three sides, to far more elaborate structures with provisions for feed and bedding storage, and young stock.

The basic structure of the milking and milk-handling building varies from the bare minimum required for the production of high-quality milk, with frame walls, homemade wooden stanchions, homemade milk cooler, and crude equipment of various kinds, to high-cost buildings constructed

of glazed tile and having a great deal of manufactured steel equipment and expensive labor-saving devices.

Compared to other types of dairy building systems, it is believed that the loose housing system offers the average dairyman in the state greater advantages with respect to low building cost and more favorable labor characteristics.

Despite these advantages there are a number of unknown factors concerning loose housing which, if known, would considerably advance the value of the system to the dairy farmer.

1. **Loafing Areas.** The barn where the cows are sheltered, and, in many cases, fed roughage, is called the loafing barn commonly in Missouri. The part of the loafing barn where the cows are bedded and the manure pack is allowed to accumulate is termed the loafing area.

Certain factors affecting the design of the loafing area are open to question. The following are brought out in this connection:

a. The proper allowance of space in square feet per 1000-pound cow for a mild climate such as that of Missouri has never been established to a desirable degree of certainty.

b. The proper management of the loafing area with respect to use of bedding, frequency of cleaning, desirability of partitioning into pen space, and length of time to use in winter is subject to differing interpretation.

c. The best location of the loafing area with respect to the other parts of the system, such as the milking room, is not known.

d. The most desirable depth of accumulation of manure and bedding in the loafing area is unknown.

e. Many persons are undecided as to temperature control in the loafing area. Some feel that the area should be equipped with doors and kept closed in winter. Others believe that control of temperature is unnecessary.

f. Where the number of cows in the herd tends to fluctuate there should be some way of taking account of this in the design of the loafing area.

2. **Feeding Area.** There is considerable doubt as to the desirability of feeding roughages in the loafing area. Where roughages are fed in the loafing area it is difficult to maintain dry and reasonably clean conditions around the area where the cows are fed. The practice of providing a separate, paved area needs consideration. This would offer a solution to the problem, but usually at increased cost.

3. **Milking Barns.** There is such a variety of types of milking barns being used, the dairy farmer is justified in wondering which type offers him the most advantage. The selection of the most suitable type of milking barn has become a definite problem.

The common types of milking barns found in Missouri are as follows:

a. A group of two or more conventional stanchions, arranged in a row parallel to one another. Basically, this type is merely a small segment of the conventional stanchion barn transplanted into a separate room or building and used only for milking purposes. This is called the floor-level type because the cows, while being milked, are on the same level as the operator.

b. The elevated-stall type. In this type the cows are usually held head to tail, or tandem, and stand on a platform 6 to 32 inches above the operator while being milked. A number of different arrangements of these elevated stalls are found. The number of stalls used is variable.

4. **Feed and Bedding Storage.** The storage of hay, concentrate feed, and bedding often presents difficulty to the farmer who is interested in minimum building investment. The loafing barn may often be a one-story shed arrangement with only enough room for the loafing area. In such cases the storage of hay and bedding may involve additional construction costs.

PART II.—REVIEW OF LITERATURE

A. A Brief History of Loose Housing

Loose housing may perhaps be considered a return to the simplicity of former times, caused by difficulty in securing labor, scarcity of suitable building materials, and mechanical improvements in milking machines.

The University of Illinois conducted study of loose housing prior to 1905 (11). A survey of 18 farms which used loose housing showed that in some cases the cows were milked in the feeding barn, while in others the cows were taken into an adjoining stable for milking.

Experimental work at the Maryland Agricultural Experiment Station (5) prior to 1913 was done in a barn which had a milking barn attached to it, a practice which is common at the present time. This barn had the peculiar property of being open on all sides except where the milking barn adjoined. The walls were composed of solid concrete 5 feet high with posts supporting the roof, leaving the upper wall open for a vertical distance of 3½ feet.

Interest in the simplicity and apparent labor advantage of the new loose housing system increased until in 1914 the United States Department of Agriculture undertook experiments to determine its worth and general practicability. In the report of this research (31) it is indicated that the loose housing practice of the time usually included a loafing barn which was enclosed on three sides and open to either the south or the east. The roughage was fed in the loafing barn.

Further experimental work of the same kind was done around 1913 in Pennsylvania (18), where again the open shed type of loafing barn was used.

Fraser (12), in 1924, indicated that the closed type of barn was gaining public favor in Illinois. There was considerable interest in the use of round barns at about the same period.

Although there had been some attention paid to it in experimental work, college bulletins of the period around 1924 have very little mention of the loose housing system. This possibly indicates that farmer acceptance of loose housing had not yet arrived, at least in the northern regions of the United States (10).

Long (18) wrote that the California Agricultural Experiment Station had been advocating "the dual-structure system" since about 1925, and that, in various forms, it was widely accepted. The most widespread Cali-

ifornia design was a barn with central hay mow extending from the ground with sheds on either side. The production of whole milk in this type of structure was prohibited by health authorities. The trend then swung to one-story stanchion barns large enough to contain the entire herd at milking time. The cows were confined only at milking time.

Long stated that there was considerable interest in California in the parallel-stall walk-through type of milking barn with releaser-type milking equipment. This system was imported from New Zealand and Australia. The recommended use of this type of system included the practice of feeding concentrates before the cows enter the milking barn. He quoted a comment to the effect that on a dairy using this type of system one man was usually milking a 90-cow herd.

Another development which was receiving interest in California around 1931 was the tandem type of walk-through milking barn. In this system, Long stated that the cows were washed and fed outside before entering to be milked. He wrote that "an interesting feature which is being suggested for this system is the placing of the milker on a level below that of the cows to minimize the stooping necessary."

In 1932, Strahan (28) discussed the implications of the increasing interest in the use of barns for milking only, with shelter and feeding provided elsewhere. He stated that "The principal impetus to the latest trend was contributed by Dr. R. R. Graves of the Bureau of Dairy Industry, U. S. Department of Agriculture. He suggested that a well-known principle of factory management be applied to the milking operation on the farm, namely, 'bring the work to the machine.'"

Strahan pointed out that the trend was toward milking barns of two types: the tandem walk-through type with elevated platform, and the parallel walk-through floor-level type. He stated that it was not unreasonable to expect even small herds to come under the influence of this "revolutionary trend".

Loose housing was introduced into Missouri about 1932 (16). Some of the early systems employed old barns as loafing barns, and built two- or three-stall milking barn-milk house combination structures to handle the milking operation. The tandem walk-through type of milking barn was used, without having an elevated platform. Huff (16) indicated that by 1939 the loose housing system was gaining in popularity and acceptance, and predicted that the future would bring an increase in their numbers.

In Washington state, a report in 1941 (14) indicated that loose housing had been adopted and was well-developed. The tandem-stall elevated-platform type of milking barn was used; and the practice of feeding of roughages in the loafing areas had its advocates.

The Montana State College developed a new type of elevated-stall milking barn in 1945 and 1946 (29). In this plan the cows stand "abreast" in pairs on the elevated platform, with an operator's pit located between each pair. This type was meant to be managed on a "production line" basis, with cows arriving and leaving continually instead of in groups.

The State College of Washington issued a bulletin in 1948 (27) which showed some of the loose housing practices in that state. There was a

trend toward the use of separate feeding and housing structures, with each type of structure open completely in one or more directions. Where feeding and loafing were provided in the same structure there was a tendency to pave the area directly in front of the feeding rack or manger. The practice of remodeling old general-purpose barns into loafing barns with integral feeding areas appeared to be popular.

A Minnesota Experiment Station publication of 1948 (9) indicated that the Montana type of milking barn, mentioned previously, was in use in Minnesota. Here again the practice of remodeling old general-purpose barns was prevalent; the roughage was fed in the loafing area provided, the manger surrounded by a paved strip. The use of uninsulated barns, freely ventilated by open doors and windows, was considered entirely feasible.

B. Review of Previous Study

1. **Effect of Temperature.** It was stated previously that one of the problems relating to loose housing was the indecision of many individuals with regard to leaving the loafing barn open or closed during severe weather. It has been believed in the past that low temperature, of itself, would cause decrease in milk production and other harmful effects on mature cows.

The temperature problems were studied at the North Dakota Station (26). The data from studies conducted for ten consecutive winters show the following conclusions:

a. Cows sheltered in a warm barn consistently used slightly more digestible protein and slightly more total digestible nutrients in the production of 100 pounds of 4 per cent fat corrected milk than did the shed-sheltered cows.

b. Shed-sheltered cows gained more weight than did the barn-sheltered cows.

Studies made at the University of Wisconsin (30) indicate confirmation of the conclusions made at the North Dakota Station. A loose housing barn with insulation and operated on the closed principle was compared to a loose housing barn without insulation and operated on the open principle. The insulated barn was provided with electric fan ventilation. The inside temperature of the open barn varied from about 15° F to 65° F, but there was no correlation between milk production and inside temperature. The inside temperature of the closed barn varied from about 40° F to about 60° F with a definite correlation of milk production to inside temperature; the milk production was lower at the lower temperatures. On the average it is apparent that the herd housed in the open barn produced slightly more milk than did the herd in the closed barn, but the differences were rather insignificant.

From these studies it can be concluded that the extra cost of insulation and mechanical ventilation usually needed for the closed-type loafing barn is not very well justified. The climate of Missouri is milder with respect to temperature than that of Wisconsin or North Dakota; therefore, since herd health and milk production did not suffer in the comparative tests

TABLE 1.—COMPARISON OF LOAFING AREA SPACE ALLOWANCES FROM A NUMBER OF DIFFERENT SOURCES

Source	Allowance (sq. ft. per cow)
Wooley (32)	50 (open barn) 75 (closed barn)
Carter and Foster (6)	45 to 50
Petersen (22)	45 for small cows 65 for large cows
USDA Circular 722 (20)	60 to 80
Michigan Circular 195 (17)	75 minimum
North Dakota Bulletin 283 (19)	45 to 60
Wisconsin Bulletin 470 (7)	50 to 100
Babson Brothers Company (2)	80 to 100
Cornell Bulletin 742 (15)	75 to 90
Barn Equipment Association (23)	85
Washington Bulletin 461 (3)	60 to 80
Minnesota Bulletin 146 (9)	50 to 75 exclusive of feeding area
Washington Bulletin 190 (27)	75 to 100
Montana Bulletin 249 (29)	60 for smaller cows 70 for larger cows

reported above, these factors should not suffer in the use of open barns in Missouri.

2. Space Allowance in Loafing Areas. The question of space allowance is important because it has a bearing on herd health, milk production, cleanliness of the cows, amount of bedding to use, and the labor requirements of the operator.

Table 1 shows a comparative tabulation of some recommendations as given in current literature. It will be seen that there is a wide variation from the minimum to the maximum space allowance, greater than 100 per cent. The loafing barn designer is handicapped when confronted with such a mass of recommendations, since it would not be sound engineering practice to vary the size of the loafing area by 100 per cent depending on which recommendation he decides to use. He should have information available which would assign a space allowance based on breed of cow, type of barn (whether open or closed), and location and size of feeding areas.

3. Bedding Use. It has often been stated in the literature, and shown in practical tests, that loose housing requires more bedding than other kinds of housing.

Fraser (13), in Illinois, stated that the use of the right quantity of bedding was very important to the success of the loose housing system. He believed that enough bedding should be used to absorb all the liquids, but that to use any more than this was harmful. Fraser stated that cows should be bedded once per day. If straw is used, and the cows are on pasture in the summer, he believed that one ton of straw per cow per year should be allowed for bedding.

Woodward (31), in reporting the studies conducted at Beltsville prior to 1918, stated that cows housed in their experimental open shed; required a daily average of 8.3 pounds of bedding per cow, but did not state precisely what kind of bedding was used. He stated that "regardless of climatic

conditions the more space allowed each cow the less bedding will be required." He further commented that proper drainage of the loafing area was of prime importance.

His statement with regard to the effect of space allowance on bedding use leads to the conclusion that in areas where bedding is scarce satisfaction can still be obtained by increasing the number of square feet per cow in the loafing area.

Witzel and Heizer (30) studied the bedding problem in Wisconsin. They used baled straw bedding during the majority of their test periods, but also used baled shavings and poor-quality hay on occasion. During their first test period they used a loafing area which had feed mangers placed in it and bedding was distributed right up to the mangers. This was found to cause unsatisfactory and filthy conditions around the mangers; they then paved the feeding area along the mangers and cleaned this area daily. Considerable improvement was gained, including a reduction in bedding requirements.

C. Limitations of Previous Study

The problem of flexibility pertains to the specialized nature of the milking barn. Many farmers are reluctant to build these structures because they are not sure they will be in the dairy business permanently. They want a structure which can be adapted to other enterprises. Such a design should appeal particularly to a landlord-tenant relationship. This problem, apparently, has never been considered seriously.

In temperature studies, the apparent main direction of the effort has been applied toward study of the effect of low temperature. The effect of high temperature, in the vicinity of 90° F and above, has been neglected. Ragsdale, Brody, and Thompson (25) found under laboratory conditions that Holsteins commenced to drop in milk production at about 80° F, and that Jerseys commenced to drop at about 85° F. These temperatures occur commonly in the summer; therefore, further work is needed to determine if these reductions in milk production would take place under actual farm conditions. If significant losses in milk production could be proven under farm conditions, then effort should be devoted toward design of partially air-conditioned structures to offset the losses.

Wherever study has been made of the bedding problem, there has been little attention paid to the relative value of different kinds of bedding. The dairy farmer should have information available which would enable him to estimate his bedding requirements with respect to the kind of bedding, geographical location, and space allowance per cow in the loafing area.

Although much study has been given to the various kinds of milking barns and parlors, there still remains the necessity for some kind of absolute measurements which can be applied to the various types of these structures. This might involve measurements of metabolism, or some similar determination of the exact amount of energy expended by a man working in the various types of milking barns. Until such a study is undertaken, comparisons of milking parlor labor characteristics must be made on the basis of time and travel studies, and are therefore subject to error.

PART III.—METHOD OF INVESTIGATION

A. Selection of Study Areas and Farms

In the selection of study areas, it was considered advisable to select areas in the state where farm dairy production was relatively new and also where such production had been established for a number of years. See Figure 1.

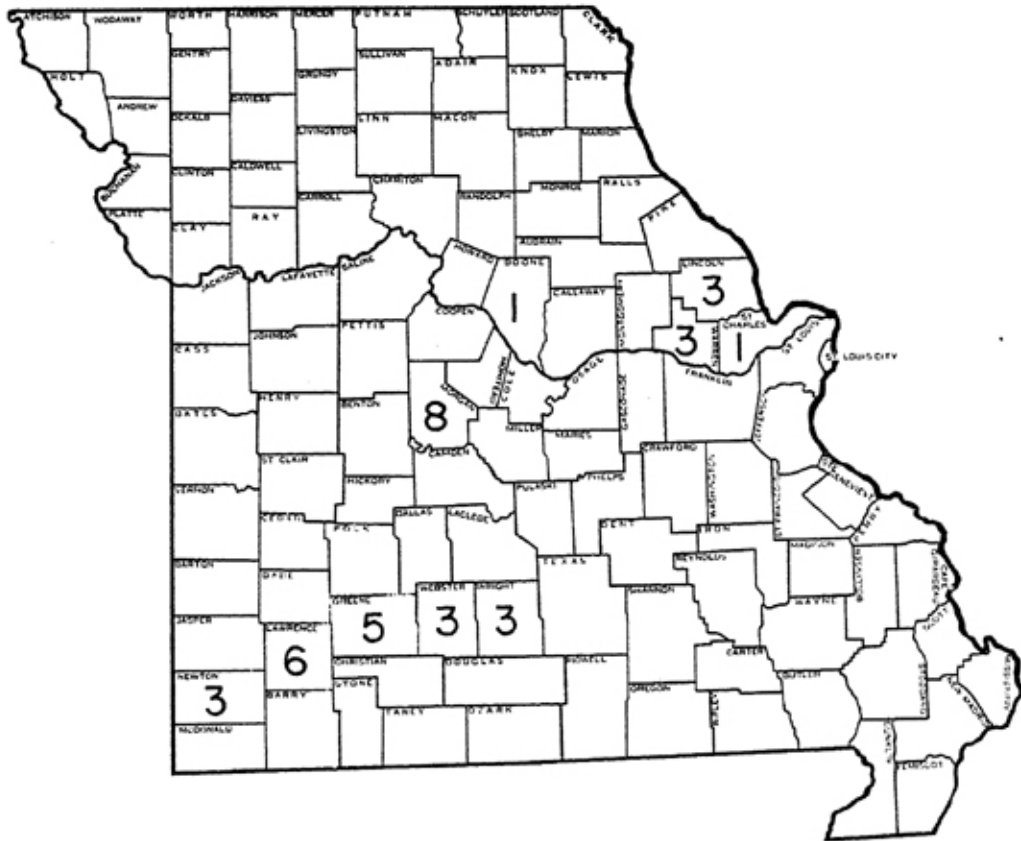


Figure 1.—Counties visited for dairy barn research. Numbers indicate number of farms studied within the county.

The southern and southwestern areas of Missouri have been established as a dairy region for many years. In the recent past dairying in this region has expanded considerably in intensity and scope. Therefore, the southern part of the state offered a composite of the two requirements mentioned above.

Morgan County was selected because practically all of its dairy system has been built up since the end of the recent war. Here all of the structures are new, with the majority of them built to rather exacting standards of sanitation requirements. Study in this area afforded a view of the loose housing practices established since World War II, at the time when high costs and lack of labor had exerted influences on design and construction.

The eastern group of counties represented by Lincoln, Warren, and St. Charles counties were selected to obtain a study region near the city of St. Louis. This region is similar to the southern region in that it is a composite of old and new types of construction.

The farm studied in Boone County was selected as an initial study case because of its close proximity to Columbia. This farm was used to test the survey forms, before using them generally.

Farms were selected for two characteristics. It was required that they be in production of Grade A milk; and it was also required that loose housing be employed.

B. Method of Collection of Data

1. **Survey Form.** The survey form, as finally developed and used to make the case studies, contained 126 questions or items to be reported on each farm studied. This form was not designed to be used by the farmer himself but rather by the investigator. Much of the information regarding physical features was obtained by observation and measurement. The management of the cows and certain features of the farm operations were discussed with the operator.

2. **Sketching.** Sketches to scale were made of the dairy structures on each farm visited. The purpose of the sketches was to furnish a record of the floor plan and layout of the buildings as found by the investigator. Possession of the scale sketches gave an opportunity for examination and evaluation of the floor plans.

3. **Time and Motion Study.** Although the study was primarily concerned with physical features of the dairy buildings, a limited number of time and motion studies of the milking and feeding operations on certain farms were made.

PART IV.—FIELD STUDY RESULTS

A. Farm Size and Herd Size

1. **Size of Farm.** The selection of farms was made on a random basis. As shown in Figure 1, the total number of farms studied was 36. The size of farms studied varied from 70 acres to 1500 acres. Figure 2 will show that the influence of the 1500-acre case tended to raise the arithmetic mean of farm sizes to an artificially high level. The values shown for mode and median farm sizes are probably more reliable than the mean size, since they are little affected by the 1500-acre case.

2. **Size of Herd.** Estimation of the size of the typical Grade A herd may often assume importance in dairy building design. The frequency distribution of herd sizes, Figure 3, gives an indication of the typical herd size at the time of study. The mean of 31 cows was affected by the one herd which contained 100 cows. As in the case of the farm sizes, the mode and median herd sizes are probably more reliable as an estimate of herd size.

3. **Breeds of Cows.** It was considered important to have some information regarding the typical breed of milk cow as found in different parts of the state. Figure 4 shows the percentage distribution of the various breeds of milk cows found in the 36 herds studied. Seventy-five per cent of the herds studied were herds of one single breed, while the remaining 25 per cent were herds containing two or more different breeds. All of the herds containing mixed breeds had only those breeds represented in them which are shown in Figure 4.

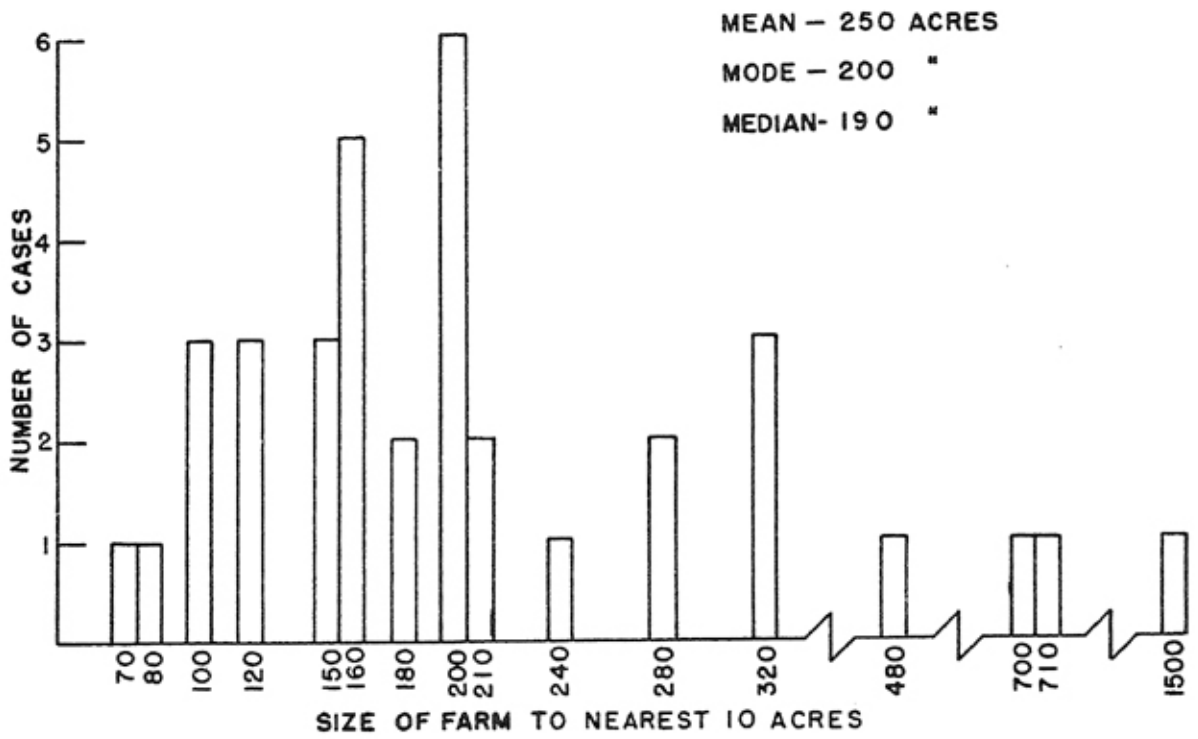


Figure 2.—Frequency distribution of farm sizes.

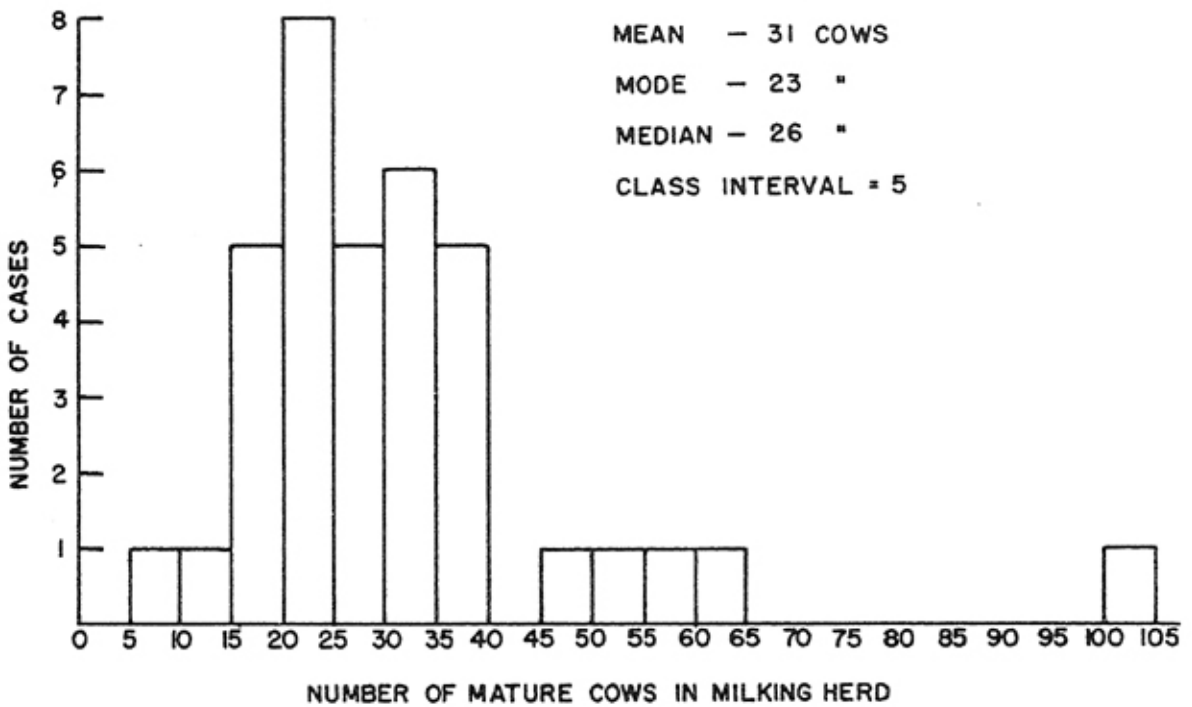


Figure 3.—Frequency distribution of herd sizes.

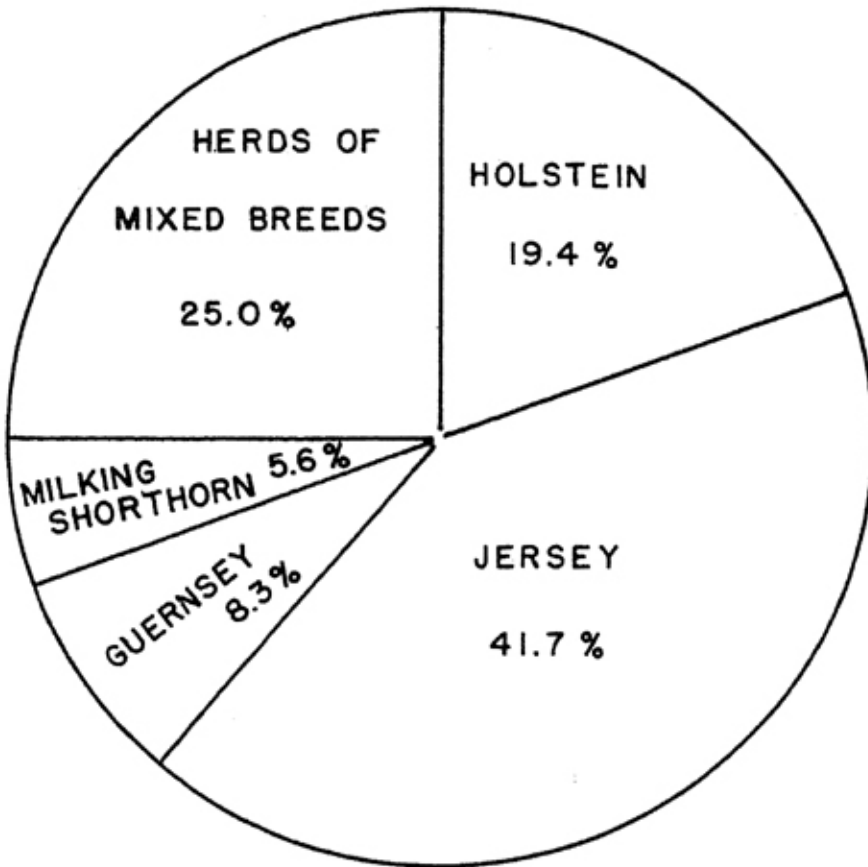


Figure 4.—Percentage distribution of cow breeds on a herd basis.

B. The Loafing Barn

1. **Types and Arrangements.** Loafing barns, as found in this study, are usually of three distinct structural types:

- a. Two-story with hay and bedding storage in the loft overhead.
- b. Two-story in height with hay and bedding stored on the ground in the center of the barn. This type will occasionally have a loft over the loafing area only.
- c. One-story in height with no provision for hay and bedding storage within the structure itself.

All of the above types may or may not have a milking room or parlor attached or built as an integral part of the structure.

In the field study it was found that of 36 cases, 23 or 64.0 per cent were classified as Type a barns; 8 or 22.1 per cent were classified as Type b barns; and 5 or 13.9 per cent were classified as Type c barns.

Figure 5 shows the floor plan of a barn of the two-story hay overhead type. This barn was built specifically as a loafing barn, a characteristic which was found to be rather rare. Of the thirty-six loose housing systems studied, only four, or about 11 per cent, had loafing barns which were built as such. All the others had loafing barns which were converted from some previous functional use, the majority having been used as general-purpose barns or as stanchion-type dairy barns.

The barn shown in Figure 5 represents a rather complete type of loafing barn in that provision is made for grain and feed storage, and for ma-

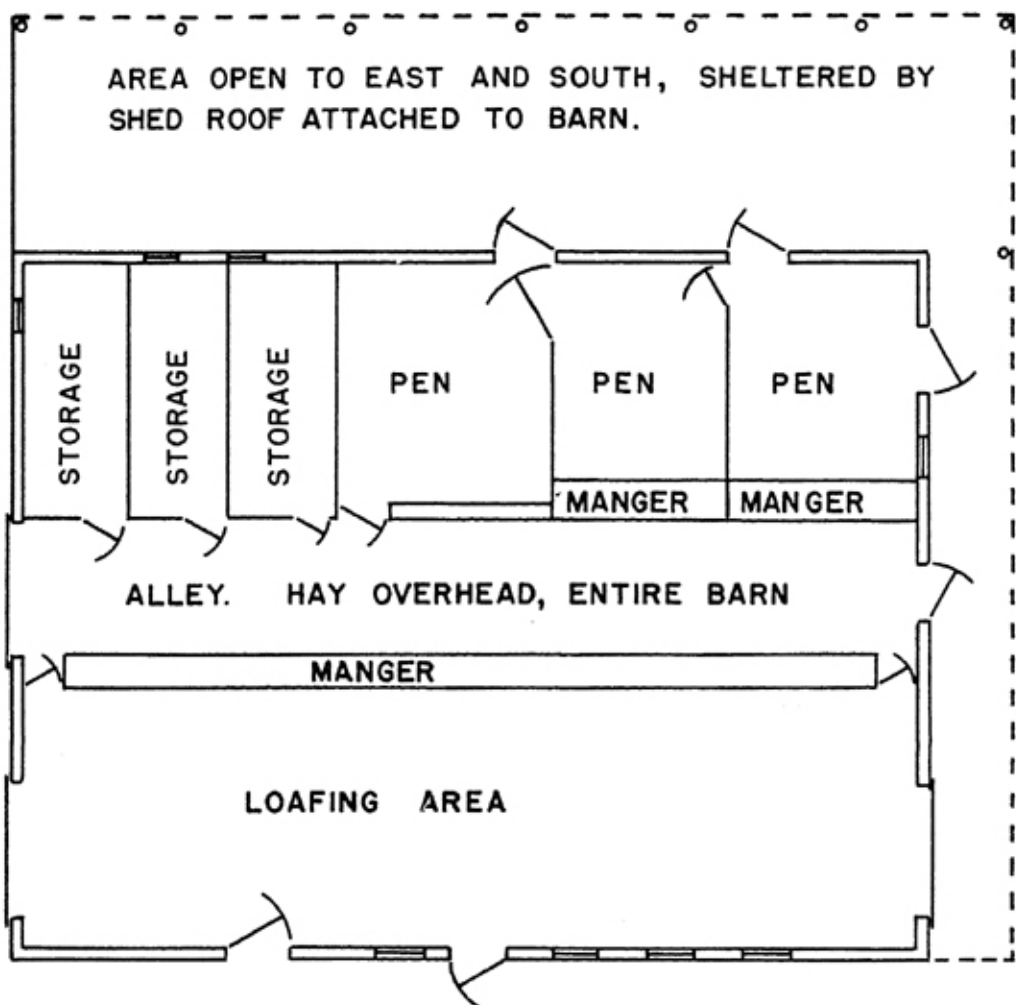


Figure 5.—Loafing barn with hay overhead, storage and pen space. The shed on the east side has a sheet metal wall on the north end.

ternity and calf pen space. These latter functions were usually found to be provided for elsewhere than in the loafing barn. The sheltered area on the east and south is furnished by a shed roof supported on posts. This barn is constructed on the closed principle; the doors can be closed in the winter so that the natural heat of the cows will be available for maintaining a temperature difference between the interior and exterior air. With the provision of calf pens in the barn, the closed principle is probably a desirable factor in maintaining healthful environmental temperatures for baby calves. There was no evidence, however, that the owner had made any attempt to solve the attendant problem of ventilation.

The arrangement of the loafing area, the owner stated, led to problems of trampled and filthy bedding in the vicinity of the manger, with hardly enough space between the manger and the wall for cows to lie down on clean bedding.

The barn plan shown in Figure 6 represents another example of the two-story hay-overhead type. The barn was not built specifically for loafing barn purposes, however, but was converted from use as a horse barn. This barn was selected for illustration as being rather typical of the type

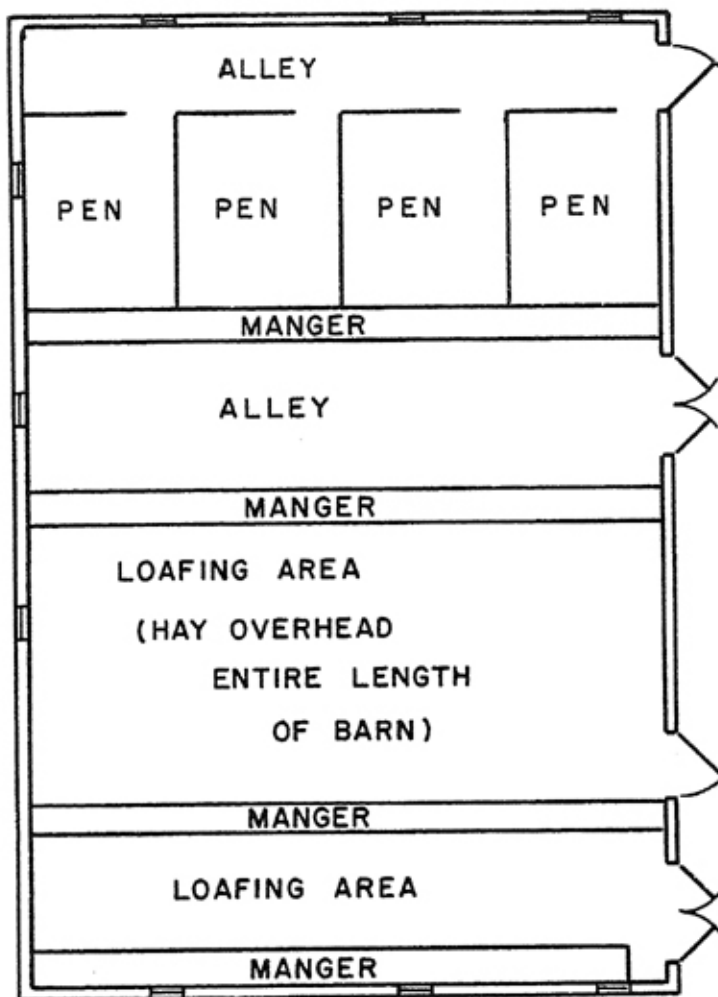


Figure 6.—Loafing barn with hay overhead of the entire barn. This arrangement is typical of the type of barn which has been converted from some previous use into use for loose housing.

of loafing barn which has been converted. It will be noted in Figure 6 that the arrangement is cut up in such a way that the usable loafing space has been reduced to a minimum. There is too much manger space provided for the amount of loafing space provided. Also, much space is wasted in alleys. The problem of feeding in such a barn is serious. The remodeling of such barns into more desirable loafing barns has received little attention.

The barn plan shown in Figure 7 was built specifically for loose housing. A floor level milking parlor is attached to the west end of the barn as a one-story addition. The manger is used for the feeding of both hay and silage, an arrangement favored by the majority of those owners who had silos constructed in the vicinity of the loafing barn. The loafing area is open to the south. Water is available in the loafing area, and the area is of sufficient depth to provide adequate shelter from drafts. The manger is located in such a way that a maximum amount of untrampled space is available to the cows. The posts which support the loft floor system offer a certain amount of interference with efficient cleaning of the loafing area.

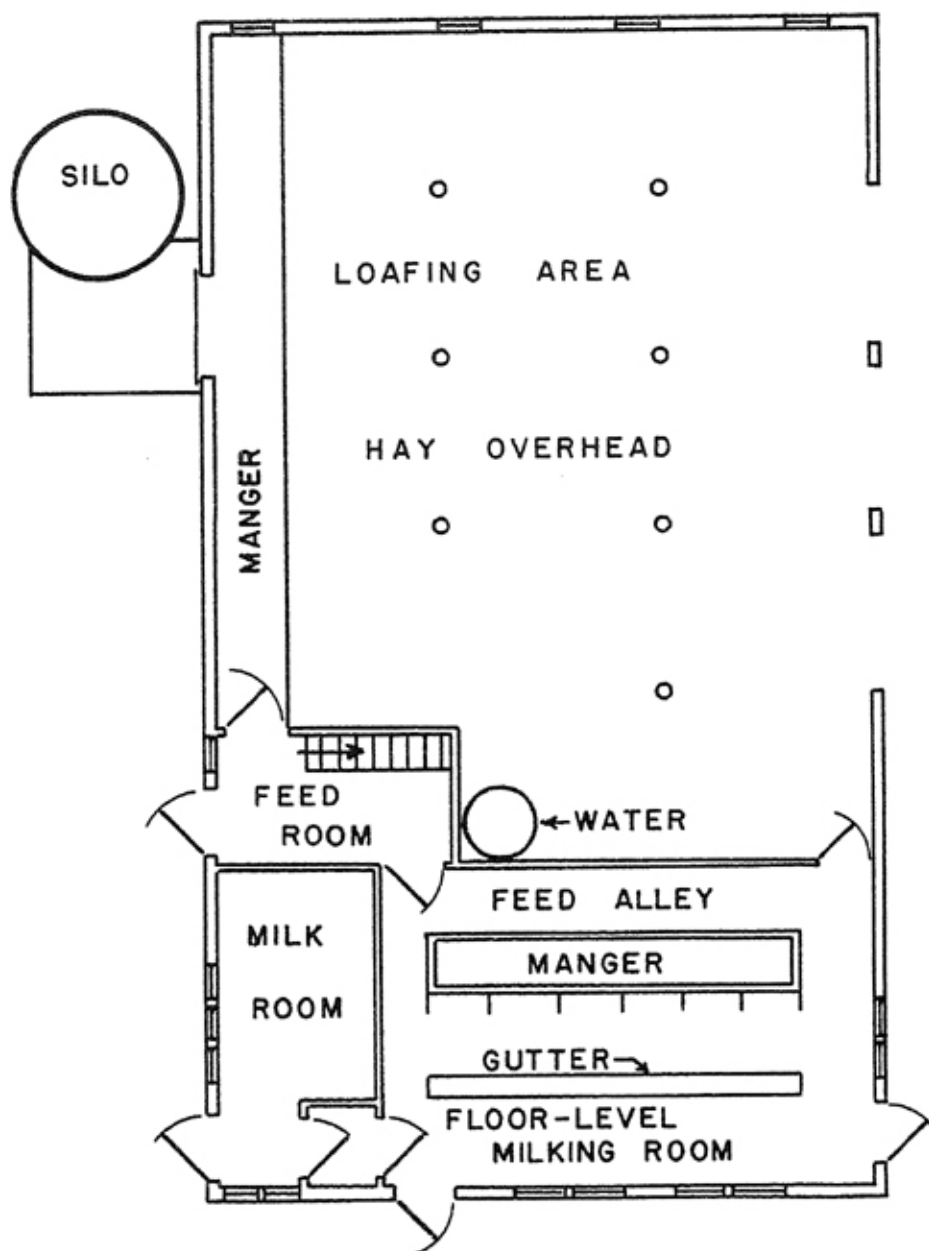


Figure 7.—Loafing barn with overhead hay storage over barn proper, and floor-level type milking parlor attached as a one-story addition on the west. The silo is connected to the manger alley by a covered runway.

The barn plan shown in Figure 8 is typical of those which have the hay stored to the ground. This type of barn is usually constructed with its frame supported by poles sunk in the ground at intervals. Built with a minimum of bracing, the poles tend to withstand lateral forces by resisting moments set up due to being sunk in the ground. The barn shown in Figure 8 was equipped with a hay drier system, the only one encountered in this study. Aside from the drier fan room, the arrangement of the barn is typical, with loafing area open to the south.

In Figure 9, the plan of a one-story, open-type loafing barn is shown. In this plan the milking room or parlor has been made an integral part of the loafing shelter. There is no provision made for roughage feed storage

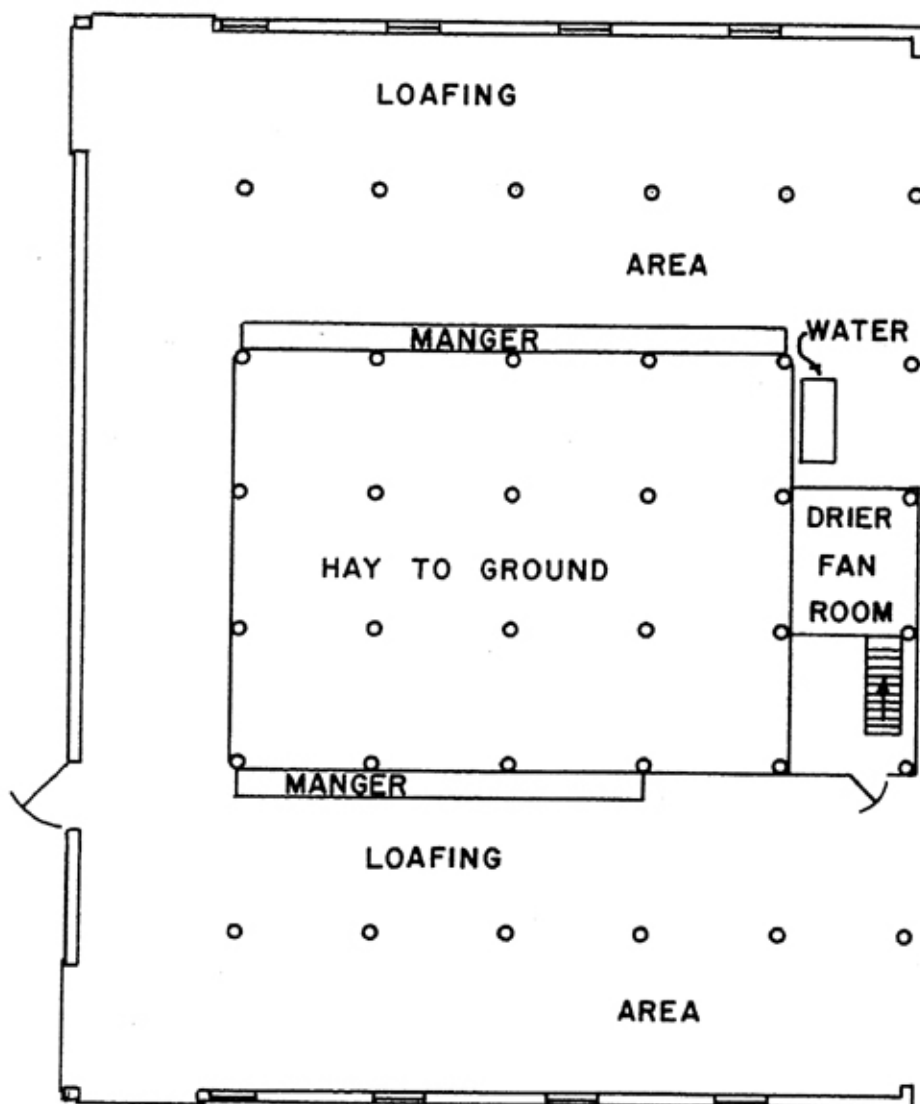


Figure 8.—Loafing barn with hay to ground at center.

in this barn, nor is there provision for storage of bedding material. There is no provision for calf or maternity pens. The manger is used for feeding of hay and silage; and, being provided with a series of home-made stanchions, is also used for grain-feeding and cleaning of the cows before they enter the milking room at milking time. The loafing area is open to the south and east. Water is provided in the loafing area, together with a holding pen to confine the cows at the milking parlor entrance at milking time.

The barn whose plan is shown in Figure 10 represents a hybrid structure, difficult to classify under the three types previously mentioned. The type of construction is the typical pole-frame type, but instead of hay to ground at the center, the hay is stored in a large bin on one side of the barn. With the hay chopped and blown in, this arrangement seemed to offer minimum labor requirement, in connection with feeding roughage. A milking room is attached on the east side of the barn. Part of the loafing area is occupied by the holding pen which is necessary to the operation of

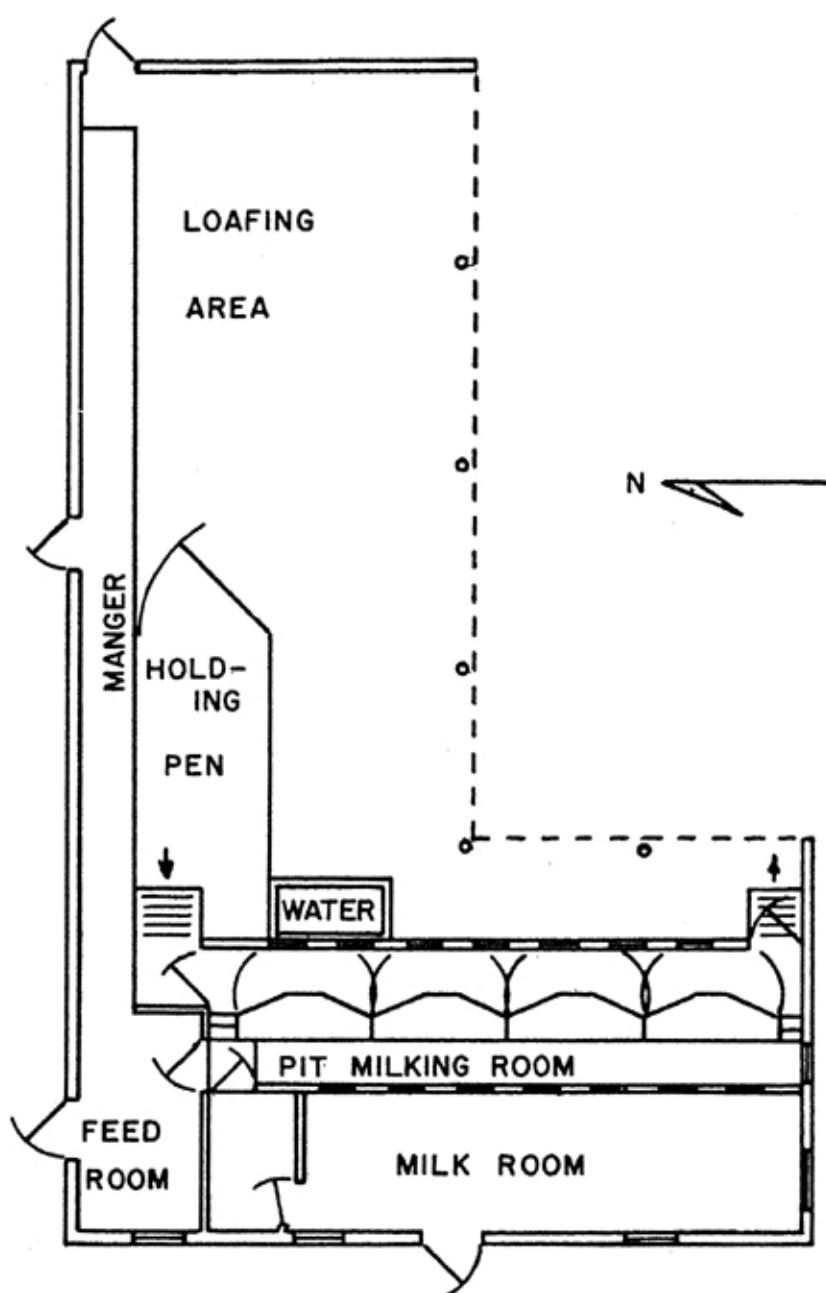


Figure 9.—Loafing barn without hay storage. The loafing area is open to the south and east. An elevated-stall milking parlor is incorporated into the loafing barn.

the milking room. This holding pen is not a permanent arrangement but is formed of a few movable panels. The loafing area is open to the south.

Only a few representative types of loafing barn floor plans are shown, since the majority of the barns studied fall in the general classifications previously mentioned.

2. **Size of Loafing Areas.** It was found that the allotment of space per cow in the loafing areas of the barns studied tended to concentrate in the range of 50 to 60 square feet per cow. This tendency is shown in Figure 11. There was a wide range of space allowance. The lowest space allowance found was 30 square feet per cow, while the highest was 110. The

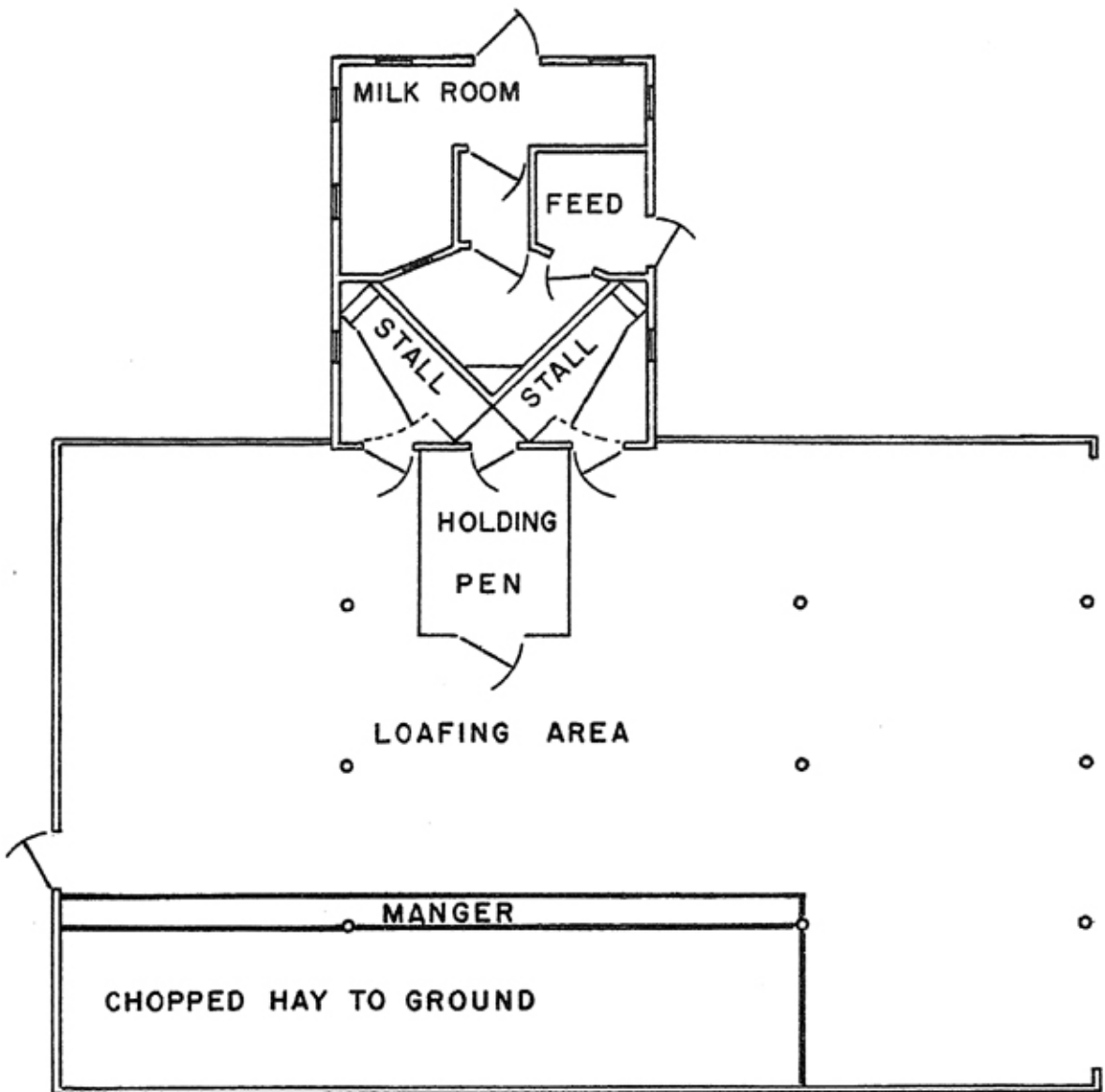


Figure 10.—Loafing barn with hay to ground and attached elevated-stall type milking parlor. The attached milking parlor is a 20' x 24' Quonset-type structure.

mean space allowance was 59 square feet per cow, the mode was 54, and the median was 57. There is no proof in these data that an allowance of 50 to 60 square feet per cow is the one figure which is correct for Missouri or similar climatic conditions, since the influence of size of cow, shape of loafing area, location and size of openings, and many other variables which might affect space allowance, were not considered in tabulating the data.

3. Relation to Milking Barn. The position of the loafing barn with respect to the milking barn is a question which may depend on the farmstead layout and whether or not the loafing barn was originally located and built as such.

The findings of this study on this point have been as follows:

Of 36 farms studied:

21 or 58.5 per cent had the milking barn attached to the loafing barn,

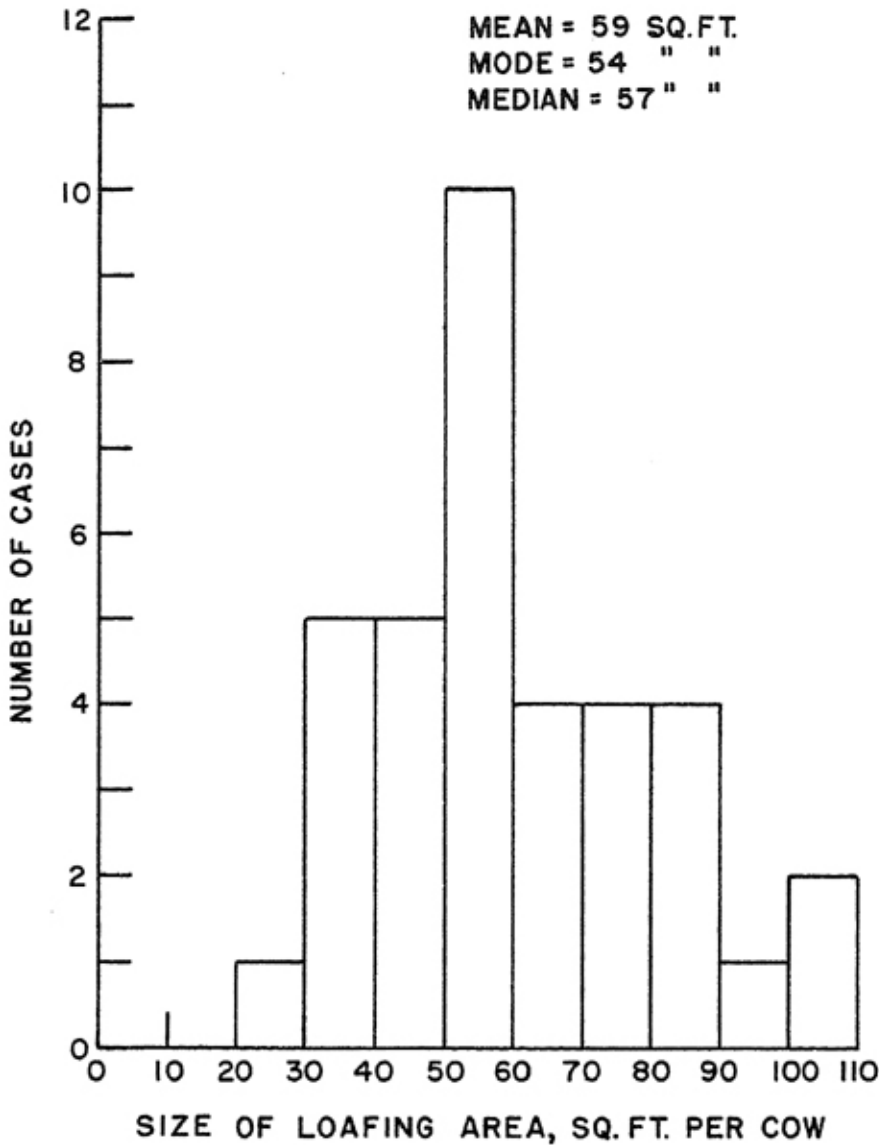


Figure 11.—Frequency distribution of space allotment per cow.

2 or 5.5 per cent had the milking barn located within 25 feet of the loafing barn,

4 or 11 per cent had the milking barn located within 50 feet of the loafing barn,

1 or 2.8 per cent had the milking barn located within 100 feet of the loafing barn, and

8 or 22.2 per cent had the milking barn located beyond 100 feet of the loafing barn.

In every case where the loafing barn had been built for that specific purpose the milking barn was constructed as a part of the loafing barn. Also, in every case where the arrangement of the service yard or court permitted, in the remodeling of existing barns into loafing barns it was found that attachment of the milking barn or milking parlor on to the old barn was preferred.

In the 8 cases which had the milking barn located more than 100 feet away from the milking barn, the situation arose due to the availability of

an open shed or shelter in some field adjacent to the building group which could serve as a loafing barn with a minimum of expenditure.

4. **Open and Closed Loafing Areas.** In classifying a loafing area as closed, it was assumed arbitrarily that the area was a closed area if the entrances and exits were equipped with doors. Many of the operators who used areas as classified above stated that they did not use the door except in the coldest weather. The so-called closed type area appears to enjoy the greatest popularity, since 27, or 75 per cent, of the barns were of that type. But the primary explanation for this may be that the typical loafing barn is a structure remodeled from some former use.

C. The Milking Barn

1. **Typical Arrangements and Types.** The milking barn, or milking parlor, may be classified with respect to the type of stalls used to confine the cows while being milked. "Stall" refers to the mechanical arrangement employed to prevent the cow from moving about at will while being milked.

Another classification for milking barns is the elevation of the stall with respect to the elevation of the operator. The stall may be on the same level as the operator's feet; or the stall floor may be raised above the operator's floor so that the operator need not stoop down.

A final suggested classification for milking barns would be the arrangement of the stalls, whether side-by-side, or end-to-end, as the case may be. The customary nomenclature for side-by-side arrangement is parallel-stall. Where the stalls are arranged end-to-end the arrangement is commonly termed tandem-stall. In the tandem arrangement the cows stand head to tail while being milked.

The suggested classification system is summarized in Table 2.

It was found in this study that the milking barns had characteristics as listed in Table 3.

TABLE 2.—CLASSIFICATION OF MILKING BARNs

Structural Feature	Possible Classification
Stall Type	Stanchion or Cage ¹
Stall Elevation	Floor Level or Elevated
Stall Arrangement	Tandem or Parallel or other

¹The word "cage" is suggested by the author as a descriptive term for the type of stall where the cow enters an enclosure by means of a gate, the gate being closed for the milking process. This will differentiate from the stanchion, where the cow is held by the neck while being milked.

TABLE 3.—MILKING BARN CHARACTERISTICS

Stall Feature	Number of Cases	
	Stanchion	Cage
Stall Type	30	6
Stall Elevation	Number of Cases	
	Floor Level	Elevated
	30	6
Stall Arrangement	Number of Cases	
	Parallel	Tandem or other
	30	5 1

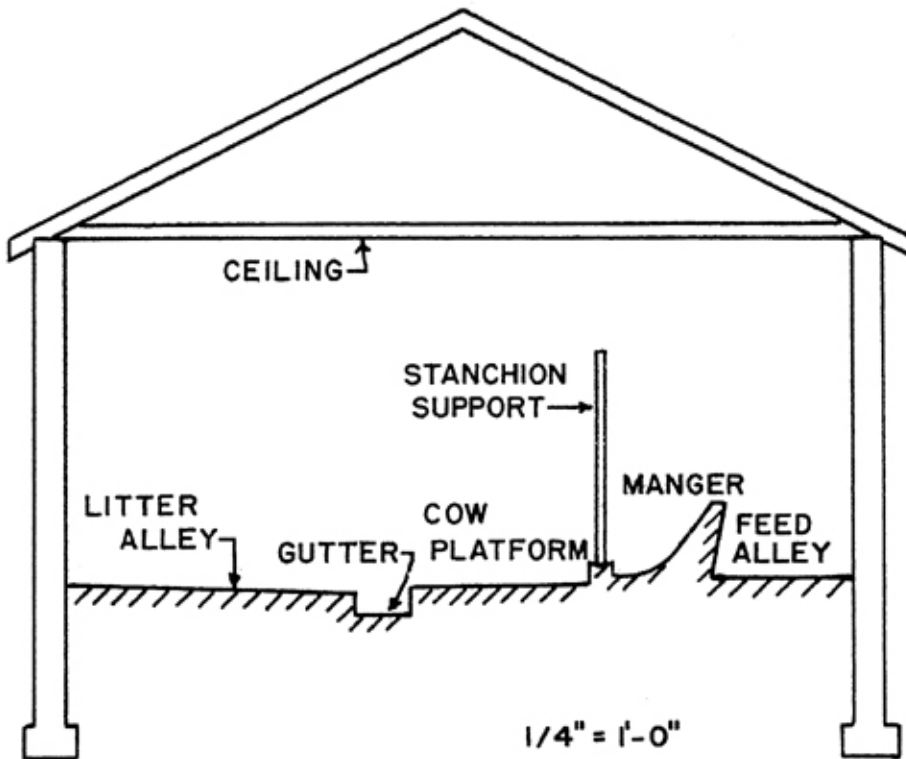


Figure 12.—Cross-sectional view of typical level-floor milking barn.

There was one stall arrangement which did not fit the classification. The case is illustrated in Figure 10 which shows that the stalls were arranged in a 90° V-type of arrangement.

From examination of Table 3 it will be seen that the floor level type of milking parlor is associated with stanchion type stalls arranged parallel. In Figure 7 is shown a typical floor plan for this type. Refer to Figure 12 for a cross-sectional view of a typical level-floor milking parlor.

It will also be seen that the elevated-stall type of milking parlor is associated with cage-type stalls arranged in tandem order. Refer to Figure 13 for cross-section-view of a typical elevated-stall type milking parlor.

2. Number of Stalls. In planning the milking barn it is helpful to know the approximate number of cows which will usually be milked through the barn. In the floor-level type it has been customary to allow stall accommodations for about 1/3 to 1/5 of the milking herd at one time. This will have the effect of allowing 3 to 5 cows per stall.

The practice regarding stall number is shown in Table 4. It will be seen that the use of elevated stalls is commonly associated with a higher rate of use per stall than the floor-level type. This does not necessarily lead to faster milking time in terms of cows per man.

3. Labor Characteristics. A limited amount of time and motion study was done. It was found that there was very little difference in labor characteristics between the elevated-stall type milking parlor and the floor level type parlor *that could be measured with a stopwatch.*

The results of the time studies are shown in Table 5.

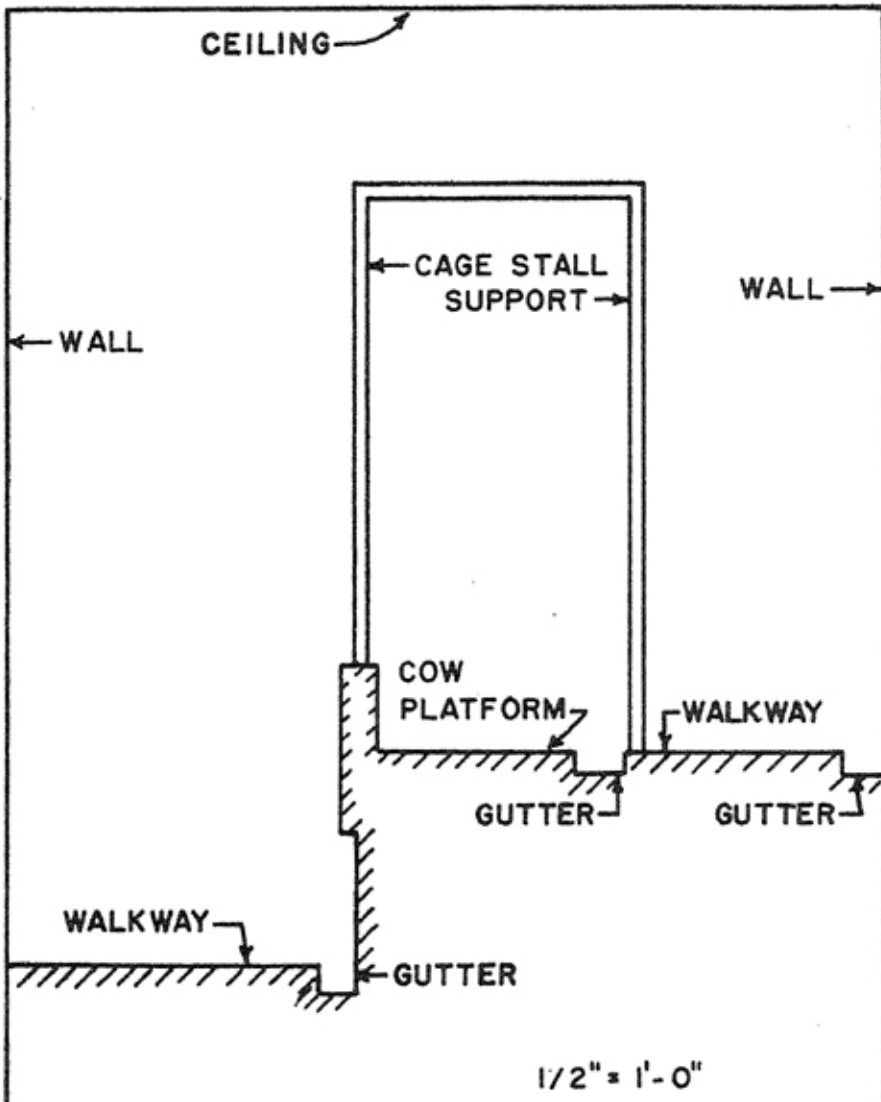


Figure 13.—Cross-sectional view of typical elevated-stall milking parlor.

TABLE 4.—STALL PRACTICE

Floor Level Type		
No. of Stalls	Cases	Average Cows Milked per Stall
5	1	5.4
6	12	3.5
8	10	4.4
9	1	4.0
10	2	6.7
12	1	2.9
14	1	0.8
17	1	2.1
22	1	1.5
Elevated Type		
2	2	14.5
3	2	10.0
4	1	4.0
6	1	6.5

TABLE 5.—TIME STUDY-MILKING OPERATION*

Type Milking Parlor	Cases	Cows Milked/Man Hour
Two Elevated Stalls	1	10.0
Three Elevated Stalls	2	11.1 and 8.0
Four Elevated Stalls	1	8.4
Eight Floor-Level Stalls	1	9.7

*The milking operation included preparation of utensils, milking, handling and pouring milk, necessary cow herding, cleaning utensils, and cleaning the work areas.

In the case of the elevated-stall type parlors, it was noted that in each case two or more persons participated in the milking operations. All of the elevated-stall parlors had the stalls arranged in tandem.

In the one floor-level type case in which time and motion study was made, milking was performed by one man.

D. The Milk-Handling Room

Typical Arrangements. The arrangement of the equipment in the milk-handling room, or milk-house as it is commonly termed, was very similar in most cases to the diagram shown in Figure 14. Practically all of the milk-houses studied had the same basic equipment: a milk-can cooler (required for Grade A production), two wash vats, a can rack, and some means of heating water. The water is usually heated electrically, by bottled gas, or by portable gasoline stove.

4. **Sizes in Relation to Production.** The floor area of the milk-house is governed by the requirements of the milk ordinance and code. These requirements are listed in Table 6.

TABLE 6.—MILK-HOUSE FLOOR AREA REQUIREMENTS BY
USPHS CODE

Milk Output in Gallons/Day	Milk-House Floor Area
Under 50	138 square feet
50 to 100	168 square feet
100 to 160	192 square feet
Add four square feet for each additional 10 gallons.	

In Figure 15 is shown a summary of the daily milk production as found in field studies, plotted in relation to the milk-house floor area. On the diagram is shown the limiting floor areas required by the code. Any point plotted to the right of the dashed line represents a milk-house which has a size in relation to production that meets the needs of the code as listed in Table 6. Six cases are shown to the left of the dashed line, indicating that these milk-houses are substandard with respect to the floor area required by the code. These six cases all occurred on farms which had been producing on the high-quality market for many years.

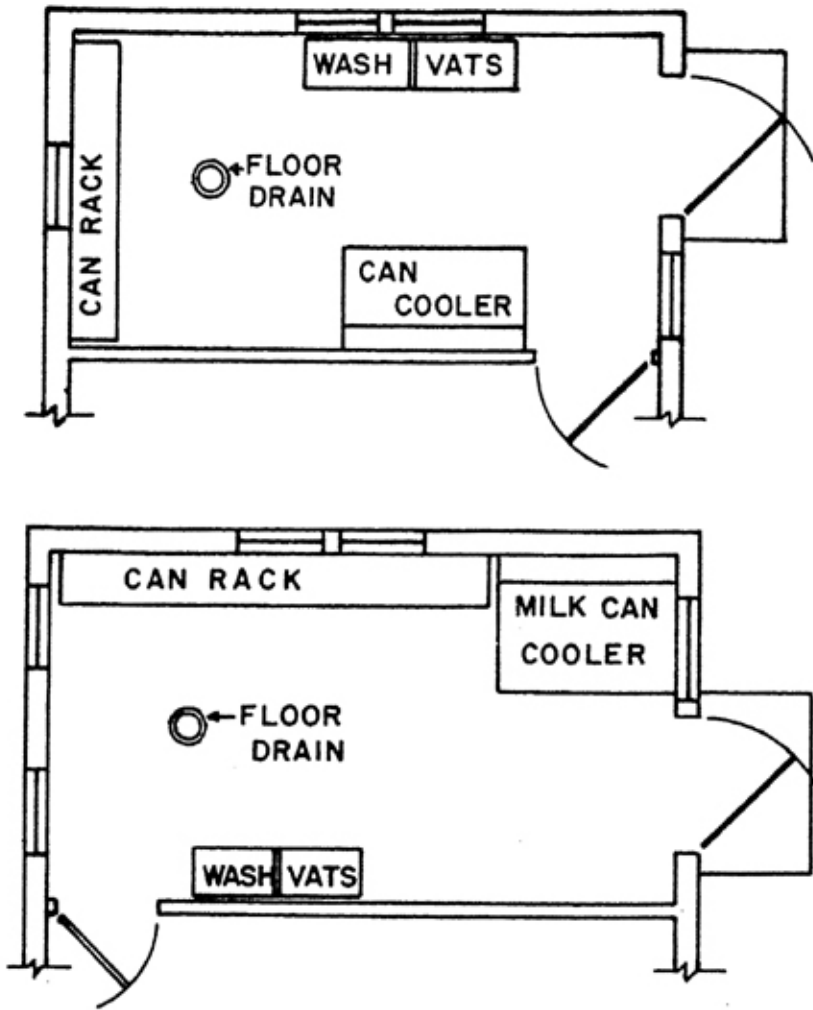


Figure 14.—Two typical arrangements of equipment in the milkhouse.

TABLE 7.—HAY CONSUMPTION PER COW PER YEAR

Farm No.	Hay Consumption Tons/Year/Cow	Farm No.	Hay Consumption Tons/Year/Cow
1	1.90	23	1.43
4	2.10	24	2.00
6	1.54	26	4.40
10	0.66	27	2.30
11	2.30	28	1.18
13	0.69	29	1.50
15	2.00	30	1.80
16	1.38	31	1.65
18	0.64	32	1.78
19	1.00	33	2.22
20	1.50	34	2.90
21	3.14	35	1.52
22	2.18	36	2.00

The average is 1.83 tons per cow per year.

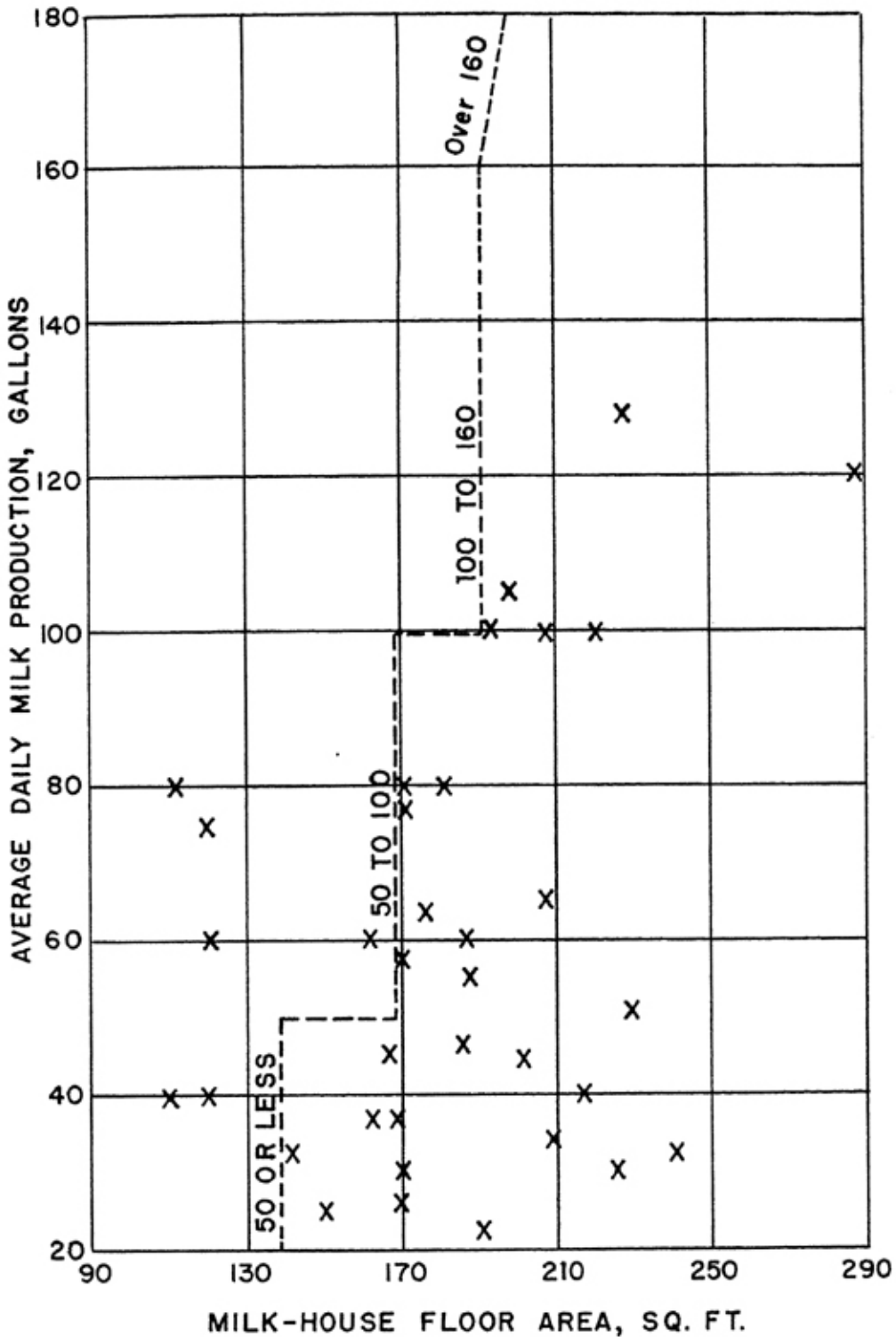


Figure 15.—Diagram of daily milk production in relation to milk-house floor area required by code.

E. Hay Storage and Feeding

In questioning the operators on the subject of hay consumption, it was found that many did not know what their herd consumption of hay in a typical year might be. For this reason Table 7 is incomplete. Table 7 shows the estimated yearly hay consumption per cow.

It should be emphasized that the figures for hay consumption are estimated by the operators, some of whom knew very closely the amount

of hay consumed by their cows, but others were not able to make even a rough estimate. The latter cases are not shown in the table.

It was found that hay was usually fed twice a day, with the hay mangers located in the loafing area. Some practiced self-feeding of hay, although only three out of the 36 followed this practice. The allotment of hay manger length per cow varied from 0.8 to 8.0 feet, but the majority allowed about 3 feet per cow.

Twenty-five, or about 69 per cent, stored baled hay. The remainder, except one, stored loose hay. The one exception stored chopped hay; see Figure 10.

The usual method of feeding hay in hay-overhead barns consisted of climbing up and pitching the hay down the chutes, then climbing back down and distributing the hay into the mangers. In the case of one-story barns with no hay storage facilities, it is usually customary to feed in a rack in the barn lot, or have haystacks located more or less conveniently for the purpose. In the hay-to-ground type of barn the hay is usually moved horizontally into the mangers when required.

F. Bedding Use

It was found that the majority of operators do not add bedding to the loafing area unless the conditions of the manure pack are such that the cows tend to get very dirty. Bedding, such as straw or poor-quality hay, is ordinarily scarce; the natural tendency is to be conservative of bedding. In the bedding study it was found only one out of five operators reported reasonably clean conditions in the loafing area *before* addition of bedding.

In the bedding study made at five of the cooperators' farms, it was found that little correlation existed between tons of bedding used per cow per month and size of loafing space in square feet per cow. Such a relationship might well exist, but the effect of shape of the loafing area, size of cows, location of mangers, and location of doors complicates the problem. Also, the type of bedding used, together with its moisture content, should affect this relationship to a marked extent. Methods of management enter into the complicating factors.

The results of the bedding study are given in Table 8.

The type of bedding used was either wheat straw or poor-quality hay. The monthly consumption is based on records kept during the months of December, January, February, and March. In many cases the loafing area will be used almost the year round, but only for shelter from rain while waiting to be milked, or for feeding of roughages. Of the five farms cooperating in the study, only Number 5 reported that he was able to maintain quite satisfactory conditions with the rate of bedding use shown. The others stated that their bedded areas were soft, damp, and smelly most of the time. From this limited amount of information it is evident that the tons of bedding used per cow may have less significance than the amount of space allotted per cow, although the results of Farm Number 3 do not confirm this.

It is interesting to note that Farm Number 5 used an average of about 6 pounds of bedding per cow per day during the winter months to maintain

TABLE 8.—BEDDING STUDY RESULTS

Farm No.	No. of Cows	Sq. Ft./Cow in Loafing Area	Average Tons per Cow per Month
1	18	48	0.0467
2	23	72	0.0955
3	30	87	0.1200
4	30	55	0.1710
5	15	86	0.0880

satisfactory conditions. In the Wisconsin studies reported by Witzel and Heizer (30) it was shown that satisfactory conditions could be maintained in an uninsulated loafing barn by use of 13 pounds of straw per cow day. Undoubtedly the milder Missouri climate will account for much of the difference in such a comparison.

G. Concentrate Feed

Every milking barn studied had a storage room for concentrates. In nearly every case the room was not used to capacity. The tendency was to haul in a supply of concentrates which would last for a week or two, thus leaving the majority of the feed room space unused. Consequently, there was a tendency for the feed room to eventually become the storage place for many miscellaneous items aside from feed.

Only one farmer of the 36 studied made a practice of home-grinding and mixing of concentrates. The usual custom is to buy the feed ready-ground and ready-mixed in 100-pound bags.

The amounts of this type of feed consumed by the cows varied widely from one farm to another. In Table 9 the amount of concentrate feed used per cow per year is shown. Some farms are missing, since, as with hay consumption, a few operators were unable to make an estimate of the amount consumed.

TABLE 9.—CONCENTRATED FEED CONSUMPTION

Farm No.	Pounds of Concentrated Feed Used per Cow per Year	Farm No.	Pounds of Concentrated Feed Used per Cow per Year
1	3400	20	300
2	2240	21	3580
3	1300	22	3000
4	1400	23	570
5	2430	24	2000
6	700	26	4000
7	2000	27	3250
8	2000	28	2240
9	1200	29	1825
11	2080	30	1270
12	2210	31	1640
13	167	32	2600
15	192	33	1330
16	1500	34	3180
17	1120	35	1009
18	260	36	3900

The average amount of concentrates used per cow per year is about 1870 pounds. This is about 5.1 pounds per cow per day.

The concentrates are usually fed in the milking room while the cows are being milked. In one case, the concentrates were fed in the loafing area before the cows entered the milking room, a practice which is sometimes used, as in this case, in the operation of the elevated-stall type of milking room.

H. Silage

One or more silos were in use on twenty-five, or about 69 per cent, of the farms. The commonly ensiled crops are corn and various grain sorghums, with grass occasionally used as silage.

Where the farms had a silo, most of the operators fed silage in the loafing area, in the same manger used for hay. The mangers were usually equipped with a solid bottom for this purpose. A minority of operators fed silage outside of the loafing barn in bunks built for silage only. In one case the silo was located in a pasture about one-half mile from the loafing barn.

The usual method of feeding silage consists of climbing up and pitching down the silage, usually into a container, such as a cart, basket, or tub. The silage is then distributed to the mangers by means of the container. This process is laborious and time-consuming, as well as dangerous.

I. Structural Summary

1. **Loafing Barns.** It was found that the majority of loafing barns are at least 25 years old. They are remodeled from such former uses as horse barns, general-purpose barns, or stanchion-type dairy barns. The remodeling usually consisted of removing as many obstacles as possible from the proposed loafing area.

The older type of barns are commonly of post-frame construction. The frame is built of wood members, sometimes with the bark still on them. The frame is tied together by mortises, tenons, and pins in many cases. Nailing and toe-nailing of members is a common practice.

The older barns are more likely to have gable roofs than gambrel or arched roofs. These gable roofs may sometimes cover a rather wide span, 40 feet in some cases; therefore, the rafters are usually supported between the peak and plate by purlin systems which are supported in turn by columns.

The newer barns are likely to have gambrel roofs, with the Gothic arch rafter seen also. Where gambrel roofs are constructed it is customary to use a system of trussed rafters on about two-foot centers, rather than true trusses which support the roof through purlins.

2. **Milking Barns.** The majority of the milking barns are new. Those which fall in this category are usually constructed with walls of concrete unit masonry. The older type of milking barn is usually of wood frame construction with metal roofing. The use of asphalt shingle roofing is common on the new barns as is aluminum.

The windows of the milking barn may often be of the steel-frame type

sash, but are also commonly wood sash. The windows are always arranged so that they may be opened for ventilation.

The doors of the milking barn are usually made on the site from one-inch lumber. The usual practice is to allow about 3½ feet of width for an opening through which a cow may pass. It is notable that the exterior door of the milkhouse is made of such a size as to allow the passage of the milk-can cooler through it.

The milking barn is usually provided with one or more natural-gravity type ventilator heads on the roof. A common practice, required by the milk ordinance and code, is to have a direct flue from the ceiling of the milkhouse to one ventilator head, with another ventilating head provided to vent the loft space of the one-story building.

The design and construction of the milking barn, and the materials used in it, are governed largely by the code sanitation requirements.

Two milking barns studied had been converted from some previous functional use. One was converted from a large poultry house; the other was converted from a combination filling station and residence.

PART V.—SUMMARY AND CONCLUSIONS

A. Summary

The production of high quality milk is an industry of major proportions in the state of Missouri. This production, however, is not ordinarily of sufficient capacity to meet the demands of the various Missouri milk-sheds. One reason for this situation is the difficulties which usually attend the efforts of the farm milk producer to obtain suitable buildings in which to produce milk of commercial quality and quantity. The dairy farmer is compelled to produce in buildings which meet the requirements of the milk ordinance and code. Construction costs are high. The labor associated with farm production of milk is usually greater in comparison to most other farm enterprises.

It has long been known through research and practical experience that loose housing of dairy cattle offers the small producer several advantages in comparison to other types of dairy housing. The cost of necessary buildings can usually be brought down to a reasonable level by use of structures which may already exist on the farm. It has been shown in many cases that the labor requirement in operation of loose housing systems is less than for other types of dairy-building systems.

The loose housing system is commonly operated with several component buildings. These buildings are: (1) the loafing barn, with facilities for feeding roughages, and possibly space for calves and young stock; (2) the milking barn, used only for milking the cows,* and kept to a high degree of sanitation; (3) the milk-handling room, which may possibly be a part of the milking barn.

The best relationships of the component buildings of the loose housing

*Feeding of concentrates is usually, but not always, done in the milking barn.

system are still largely unknown. The amount of loafing space per cow is questionable. The number, type, and arrangement of stalls in the milking barn which may be optimum for a given herd and labor supply are not known to an accurate degree. The best methods of storing and feeding hay, silage, and concentrates are unknown.

Under these conditions it is difficult to develop plans and designs for loose housing systems, in order to aid the potential high-quality producer to solve his dairy structures problem.

In this investigation a field study was made of 36 dairy farms which use the loose housing system for production of high-quality milk. The purpose of the field study was to establish the present practice in loose housing to a more precise degree than has heretofore been available. Such an estimate of present practice, with respect to structures and management, was deemed a necessary preliminary step toward further research and development of the loose housing concept.

B. Conclusions

1. Loafing Barn Practice.

a. Very few loafing barns are seen which were actually designed and constructed for such purposes. The usual type of loafing barn is one which has been remodeled from some previous use.

b. The type construction of the loafing barn may fall under three general categories: (1) two-story with hay stored overhead, (2) two-story with hay stored to the ground, and (3) one-story with no provision for storing hay, usually little more than an open shed.

c. The typical loafing area is one which allows 50 to 60 square feet of space to each cow.

d. Many of the operators make no provision for calves and young stock in the loafing barn, preferring to use facilities elsewhere in the farmstead group.

e. There is a definite trend toward the use of open loafing areas, with no attempt to control temperature. If open, the area will be open to the south or east, or both.

f. Many different shapes of loafing or bedded areas are seen, but the most satisfactory are apparently those which have a ratio of length to width of 2 or less.

g. Since over 58 per cent of the farms studied made a practice of artificial insemination, the provision of a special building for bull housing is comparatively rare.

h. The accumulation of manure and bedding on the floor of the loafing area, called *manure pack*, is usually cleaned out twice yearly by power equipment. The manure pack depth at time of cleaning will vary from 1.5 to 3 feet, depending on the space per cow and other factors.

i. The loafing area is used intensively during the winter months of December, January, February, and March. It is used to some extent throughout the year to provide shelter from rain, particularly, in some cases, while the cows are waiting to be milked.

j. The provision of water for drinking in the loafing area is a common practice.

k. Many operators considered that the provision of paved lot space adjacent to the loafing barn, and at entrance and exit of the milking barn, would have advantages. In most cases, however, this practice is not common due to high cost of paving.

l. It is not customary to separate the roughage feeding area from the loafing area.

m. Dry cows are usually kept separate from the milking cows.

n. The floor of the loafing area is commonly made of earth, cinders, or gravel.

2. Milking Barn Practice.

a. The most common type of milking barn seen at present in Missouri is the floor-level type with 6 to 8 stalls, usually combined with the milk-handling room under one roof.

b. The elevated-stall type of milking barn is increasing in number. These buildings also commonly have the milk-house as an integral part.

c. Milking barns of either type are rarely operated by one man at milking time; it is usual for members of the family to help at milking time even with small herds.

d. From the limited time study performed there appears to be little difference in milking capacity in terms of cows per man-hour between the floor level and the elevated-stall types of milking barns.

e. The conventional type milking machine is most commonly used, but the low-cost combine type milker with direct pipeline from cow to milk-can is becoming popular.

f. The prevailing custom at present is to feed concentrates while milking, but some who use the elevated-stall type milking barn are feeding the concentrates before the cows enter the milking room.

g. The floor-level type milking barn is usually operated by filling all the stalls at one time. The cows are then milked as a group and released as a group.

h. The elevated-stall type is operated on the production-line principle, with cows entering and leaving individually.

i. The usual number of stalls in the elevated-stall type milking barn is two or three. Each stall is expected to handle from 4 to 15 cows at milking time.

j. In the floor-level type milking barn each stall is expected to handle from 3 to 6 cows at milking time.

k. The milking barn, usually combined with the milk-house, is commonly attached, or built on, to the loafing barn.

l. In operation, it was noted that no difficulty was encountered in getting the cows to enter the milking barn. Difficulty frequently occurs in getting the cows to leave.

m. Many operators have no running water in the milking room; in cleaning, the floor is sprinkled with powdered limestone and swept out.

n. The design and construction of the milking barn is governed

largely by the milk ordinance and code as it applies to dairy barns. All floors are of concrete, for example.

3. Milk-Handling Room Practice.

a. In general, the construction is in accordance with the provisions of the milk ordinance and code.

b. The milk-house is usually made a part of the milking barn, with connection made to the milking room by a passage with a door at each end.

c. The usual milk-house equipment includes a cooler (usually an electric refrigerator type), a rack for storing milk cans upside down, double wash vats for washing and sterilizing of utensils, and some means of heating water. A heating device for winter use is sometimes found.

d. The use of special equipment for handling milk cans, such as hoists, overhead tracks, and roller-conveyors, is not common.

e. A natural-draft type ventilator is commonly provided which is used to ventilate only the milk-house.

f. Running water is always available.

g. The outside entrance to the milk-house is always available to the farmstead service court.

4. Feed and Bedding Practice.

a. Feeding of hay is usually done in the loafing area. Silage is often fed in the loafing area, but is also fed outside, depending on the location of the silo.

b. Many Missouri dairy farms do not have silos.

c. Hay is commonly fed at the rate of about 1.5 to 2 tons per cow per year.

d. An allowance of about 3 feet per cow is commonly made on hay manger length.

e. Self-feeding of hay in the loafing area is usually not practiced.

f. Concentrate feeds are usually fed in the milking barn, during milking.

g. Concentrate feed is commonly fed at the rate of about 1870 pounds per cow per year.

h. The milking barn will usually have a feed room built in it for the purpose of storing concentrate feed. This feed room is rarely used to capacity for feed storage.

i. The usual type of bedding used is straw or poor-quality hay. In some areas the use of sawdust is quite common for bedding down the loafing area. If straw is used, it is commonly stored in bales.

j. Most operators do not add bedding until the unclean conditions in the loafing area force them to do so.

k. It is possible to maintain satisfactory conditions in winter time use of the loafing area by addition of about 6 or 7 pounds of straw per cow per day.

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