A STUDY OF DAIRY CHORE LABOR UNDER DIFFERENT SYSTEMS OF FREE-STALL HOUSING

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ABSTRACT

A STUDY OF DAIRY CHORE LABOR UNDER DIFFERENT SYSTEMS OF FREE-STALL HOUSING

by D. Lyall MacLachlan

Sixteen dairy farms, with herds ranging from 50 to 125 milk cows were selected throughout the state of Michigan for this labor study. On all farms the dairy housing was either new or had been recently remodelled to include free-stalls, milking parlors, and silage storage with feeding facilities. Eight of the farms had installed a liquid manure system while the remaining eight used a conventional manure handling method. Three types of free-stall housing known as open-lot, cold-covered, and warm enclosed were examined.

Objectives of this study were:

1. To determine advantages and disadvantages of the different systems of free-stall housing for dairy cattle, and more specifically to compare labor requirements for farms which fed silage outdoors with those where silage was fed in the barn.
2. To evaluate different milking parlors and the potential of liquid manure handling in both open-

lot and covered systems of housing from a labor standpoint.

During the fall and winter of 1966-67, one day a month was spent on each farm to observe and record the time spent doing the different chores associated with the milking herd.

Results of this study indicated that 55 percent of the total chore time for the milking herd was spent milking. With one person working, the double four herringbone parlor had the highest milking rate in cows milked per man hour. The double eight herringbone parlor, which is always a two man operation, was second to the double four herringbone in labor efficiency.

The total chore time for the milking herd ranged from 27.9 to 55.1 man hours per cow per year. When comparing inside feeding to outside feeding without regard to manure handling, there was a saving of some three man hours per cow per year in favor of inside feeding.

Inside feeding with liquid manure handling was the most efficient, while outside feeding with liquid manure had the highest labor requirement. On a per cow basis there was a difference of ten man hours per year. However, there was no difference in manure handling when compared without regard to the type of housing. To achieve maximum labor efficiency in covered housing liquid manure should be given consideration as a component part of the system.

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INTRODUCTION

Each year the number of Michigan dairy farms continues to decline while those remaining expand into larger units. However on many of the larger farms the labor force has remained constant or decreased as the milking herd increased in numbers and production. New labor saving equipment and cow handling systems have greatly increased such ratios as cows per man and pounds of milk sold per man.

The introduction of machine milking was one of the earliest technological changes, where hand labor was replaced by a machine. Improvements of the basic machine have resulted in today's milking machines which are dependable and efficient. The idea of handling cows in loose housing was an advancement because it permitted the cow to come to be milked or fed rather than the operator going to each animal individually. This system of cow handling worked well with parlor milking and labor efficiency was increased further with the introduction of the herringbone parlor to Michigan in 1957. Mechanized silage feeding for both haylage and corn silage has resulted in reduced labor requirements for both storing and feeding these forages. The introduction of free stalls has produced cleaner cows with less bedding.

Presently, Michigan dairymen are building several types of loose housing for dairy cattle. These can be grouped into three basic systems: open-lot, cold-covered, and warm-enclosed free-stall housing. The open-lot system includes a free stall barn, feeding facilities and a milking unit. In this system each building is separate and the cows move from one to other across an open paved lot. The cold-covered system includes free stalls, silage feeding and a milking unit all under one roof. The loafing and feeding area is designed to approximate outside temperatures and ventilation is by natural air movement. The warm-enclosed system is similar in layout of free stalls, silage feeding and milking unit, but differs in that insulation and mechanical ventilation have been installed to maintain a desired inside temperature and humidity irrespective of outside climatic conditions.

The consistency of manure in free-stall housing is altered because much less bedding is used than in ordinary manure pack system. This sloppy manure coupled with trend to larger herds is making the disposal of animal wastes a major problem. Many dairymen are considering the handling of manure in a liquid form as a possible solution.

The major purpose of this study was to determine advantages and disadvantages of the different systems of free-stall housing for dairy cattle, and more specifically, to compare labor requirements for farms which fed silage

outdoors with those where silage was fed in the barn. Other reasons for the study were to evaluate different milking parlors and the potential of liquid manure handling in both open-lot and covered systems of housing from a labor standpoint.

REVIEW OF LITERATURE

Several investigators have reported on the labor requirements for individual dairy chores, but no research has been conducted on comparing the labor efficiency for different types of free-stall housing. Today's dairyman is faced with a labor shortage and increasing land prices, but these problems are not peculiar to these times as many agriculturists are inclined to believe.

In 1905 Fraser (8) reporting on the advantages of open housing over stanchion barns made the following comment.

> On many dairy farms the question of getting sufficient help is becoming such a problem as to interfere seriously with this branch of agriculture. As it seems to be the opinion of the majority of people who have practiced this method, that it saves labor, this is one of the strong points in its favor. Since land is becoming so high priced no farmer can afford to allow any fertility to be wasted and by this method all the liquid is saved as it is absorbed by the bedding.

Although the above statement was made over 60 years ago it is still applicable today.

Milking Systems

Both from a labor and profit standpoint, the chore of milking is one of the more important jobs on a dairy farm. During the twentieth century great strides have been made to

replace hand milking with machines; so that today several systems of machine milking are available to dairymen. A comparison of different milking systems by Meek (20) indicates capacities of 25.4, 20.6, 19.8, and 15.4 cows per man hour for parlors, pipelines, dumping stations, and buckets. The latter three refer to milking in a stanchion barn. The general labor saving of parlor milking have been pointed out by Meek and other researchers, but here again there is considerable variation within parlors.

Brown et al. (4) in 1959 found the double-3 walk thru, 3-u side opening, 3-in-line side opening parlors required 23, 43, and 71 percent more time than a double 5 herringbone to milk the same number of cows.

Chambliss (5) reported that the herringbone system required 1.1 fewer man minutes per cow per day than other parlors.

The principal features of the herringbone parlor were developed by W. L. Boyce of New South Wales, Australia in 1910 (7). In his system of echelon stalls the cows were angle parked on two slightly raised parallel platforms separated by a passage in which the milkers worked. As time passed its popularity waned mainly because this system was inconvenient both for handmilking and handstripping which were regarded as essential in the early days of machine milking.

A farmer named Ron Sharp of New Zealand in 1952 adapted his walk-through parlor into what was to be known as a herringbone parlor. The first herringbone milking system constructed in the United States was patterned after the double 8 parlor used in New Zealand. This was in the early part of 1957 and by the end of 1958 there were at least 80 herringbone systems in Michigan either in operation or in some stage of construction (11).

Early reports varied considerably in the number of milking units one could handle satisfactory in the herringbone parlor. At first there was a wide range from 3 to 8 units but, it was soon realized that 4, 5, or 6 units per man were more suitable. An Indiana study (22) showed that one man can milk almost as many cows with a double 4 herringbone as with a double 5 or 6 herringbone parlor. Later studies also demonstrated the double four herringbone parlor to be a suitable one-man operation.

Free-Stalls

Free-stalls were first used by Adolph Oien of Snohomish County in the state of Washington in 1960. Hoglund et al. (12) found there were only 20 free-stall units in operation in Michigan in 1963, but since then their numbers have rapidly increased. Researchers Jongenson (13), Maddex (18), and Schmisseur et al. (24) estimated bedding requirements were reduced by 75 to 80 percent with free-stalls over loose-housing.

In a study of Indiana farms Wadsworth (27) concluded that the installation of free-stalls saved 2.7 hours of labor per cow per year for farmers who had previously used loose housing and 6.5 hours for those who had previously used stanchion barns. Over one-half of the time saved when switching from a stanchion barn was the result of reduced manure removal time. Most of the labor savings for farmers putting free-stalls in former loose-housing sheds was caused by reducing bedding time. However in another study Purdue University (25) obtained labor requirements of 2.9 to 3.0 man hours per cow per year for free stalls as against 1.9 to 2.3 man hours per cow per year for loose-housing. It was concluded that scraping the alley daily or twice a day accounted for this difference.

Silage Feeding

In Michigan, there has been a trend to more loose-housing for dairy cattle, coupled with a marked increase in silage feeding, both corn silage and haylage. Feeding silage in the loose-housing system usually involves the supervision of machinery while in many stanchion barns, the silage is handled manually.

Ronnfelt (23) states when silage is the only rough-age for cows, three times as much weight was handled as when hay alone was fed. However, a silage feeding program is preferred by most dairymen because of easier handling and mechanization possibilities.

In a study (17) of 17 New York State farms which used a high silage feeding, almost all farmers listed mechanization and efficiency, as the two important advantages of silage feeding over other systems of forage handling.

Manure Handling

The introduction of free stalls to dairy cattle housing created new problems in manure handling which have resulted in much interest in liquid manure. Most popular articles on liquid manure advocate labor saving as one of the main advantages of this system, in spite of the fact that little research has been done on the labor requirements for liquid manure as compared to other manure handling methods. In the popular articles a clear distinction may not have been made between convenience and actual labor saving. Speicher (26) and Maddex (19) of Michigan State University reported savings of about 5 minutes per week per cow for liquid manure handling over built-up manure pack.

Some dairymen of European descent in the states of Oregon and Washington have used liquid manure systems for their dairy cattle with favorable results for many years. It is reported that one can pump and spread the manure from 120 cows accumulated over a three week period in one day (1).

Irwin and McKee (14) describe the herringbone parlor and loose housing arrangement as a major new technology in milk production. It usually requires a large new investment

in milking facilities but reduces the amount of labor required per cow.

Loose-Housing vs. Stanchion Barns

Research comparing the labor requirements for loose-housing and stanchion barns have shown a reduction in man hours per cow in favor of loose-housing. Barr (3) concluded that work in the loose-housing barn appeared to be less tedious and tiring than similar chores in a stanchion barn. Stooping and carrying milk were involved in the milking chores in the stanchion barn and not in the loose-housing barn. It was also noted that less travel was required to perform chores in the loose-housing barn than in the stanchion barn.

A labor analysis survey at the Chore-Boy Demonstration Farm, Indiana in 1961 determined the milking operation and materials handling accounted for 57 percent and 24 percent of the total chore time (2). This was a loose-housing and milking parlor arrangement. Care of dry cows and young stock were included in this survey. With a high degree of mechanization on this farm only 3 percent of the total chore time was required for feeding hay and silage.

Metzer (21) found stanchion barns to require 84 hours of chore labor per cow per year as compared to 67 hours for cows in loose-housing barns.

A wider spread in labor requirements was established by Jarvesoo in a study of five stanchion and five pen barns

in the State of Massachusetts. The hours per cow per year were 120 and 82 respectively, which is a saving of 32 percent in favor of pen barns (15).

A detailed ten year study comparing loose-housing and stanchion barns for dairy cattle was conducted at the University of Wisconsin between 1941 and 1951 (10). Results from this study showed a labor saving of 35 percent in favor of loose-housing when an elevated stall milking parlor and pipe line milking machine were included.

A more recent project was carried out in New York State where the chore labor for 17 stanchion barns was compared with an equal number of free-stall barns (16). The free-stall barns were equipped with herringbone parlors and used a high silage forage program. Labor requirements obtained were 76 hours per cow per year for the conventional chore system and 43 hours per cow per year for the free-stall barn, herringbone parlor, high-silage chore system.

Effects of Herd Size

Regardless of the system of housing used, for most chores the average time on a per cow basis is effected by herd size (9). The time for an added cow is generally less than for the average cow presently in the herd. With most chore tasks the time required can be divided into fixed and variable. A dairyman with a small herd should devise a chore routine so that the different tasks have a low fixed

time. A Minnesota study in 1959 of some 90 farmers determined the amount of labor used annually for chore work in dairy herds of different sizes. Labor requirements ranged from 131.9 hours for a 10 cow herd to 75.2 hours for a 40 cow herd (6).

EXPERIMENTAL PROCEDURE

Types of Dairy Cattle Free-Stall Housing

By 1966 three different types of free-stall housing for dairy cattle were being constructed by Michigan dairymen. These systems are known as the open-lot, cold-covered, and warm-enclosed free-stall housing.

The open-lot housing, which is the oldest of the three, has evolved from the former loose housing barns. Here the cattle are housed in an open front free-stall barn. Silage is fed in a bunk out in the paved yard. Often, particularly in older installations, a separate front feeding hay barn is included. The milking unit is usually located nearby in a separate building. Manure is usually handled in a conventional manner where it is scraped and loaded by a tractor into a spreader to be hauled to the field. When liquid manure is used the manure tank is located under part of the paved yard. Here the manure is agitated by some mechanical means and is pumped into tanks to be spread in the field as a liquid.

In the cold-covered free-stall barns all units are enclosed under one roof, so that the cows are never exposed to the weather. Temperatures and humidity are controlled by

natural ventilation as the roof eaves and ridge are usually open to allow sufficient air movement. In summer when more air movement is necessary doors are opened on the rear side and ends of the barn. Corn silage and haylage are usually the only forages fed as no provision is made to store or feed dry hay with this system. Freezing will occur in this barn during the winter when the outside temperature drops to about $0^{o}F$ or below. If liquid manure handling is used, the manure pit is installed under the barn so that manure from the alleys can be scraped directly into the pit. The pit extends out past the walls of the barn where the agitating and pumping are done.

The warm-enclosed free-stall barn is very similar in layout to the cold covered free-stall barn. But here insulation is provided in the walls and ceiling along with mechanical ventilation to control temperature and humidity inside regardless of outside weather conditions. Under proper operating conditions freezing will not be a problem in this building during Michigan winters. Also during hot summer weather cooler temperatures are possible inside which provide more comfortable conditions for the animals. Warm-enclosed housing provides more moderate conditions for the animals both in summer and winter. Liquid manure handling is often included in this type of housing, although other manure handling arrangements can be used.

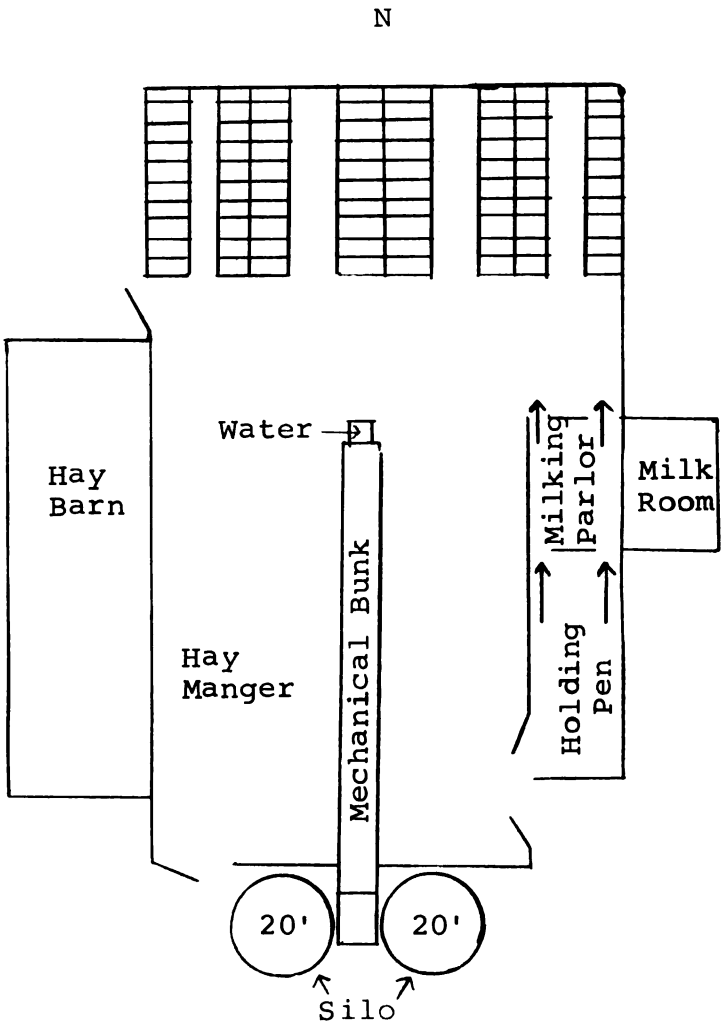

Figure 1. Eighty cow free-stall barn. Silage fed in mechanical bunk out in paved lot. Hay fed in self-feeding hay barn. Parlor milking.

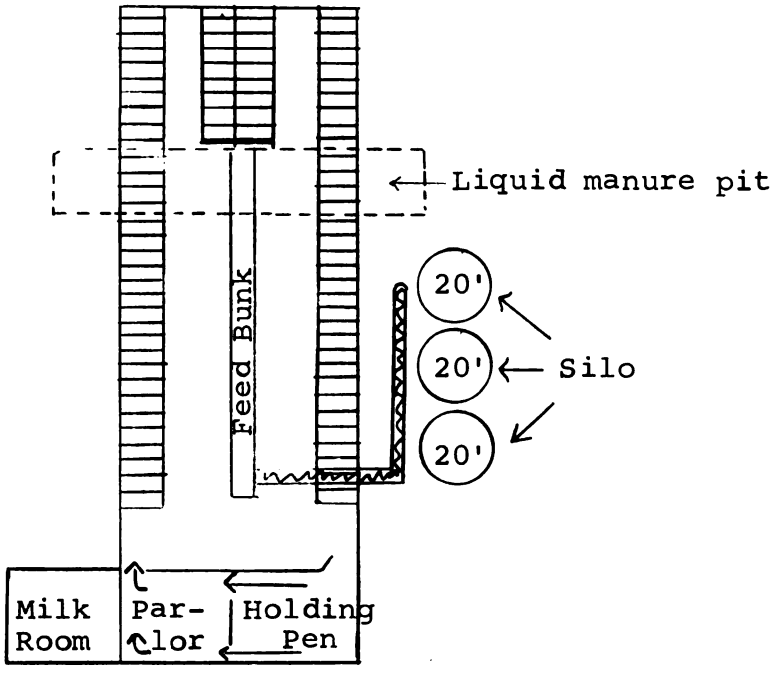

Figure 2. Eighty cow covered free-stall barn. All silage feeding, no hay. Milking, resting, and feeding area are under one roof. Eaves and ridge of roof are open at all times to provide adequate ventilation. In summer doors on sides and ends of building are opened to provide more air movement.

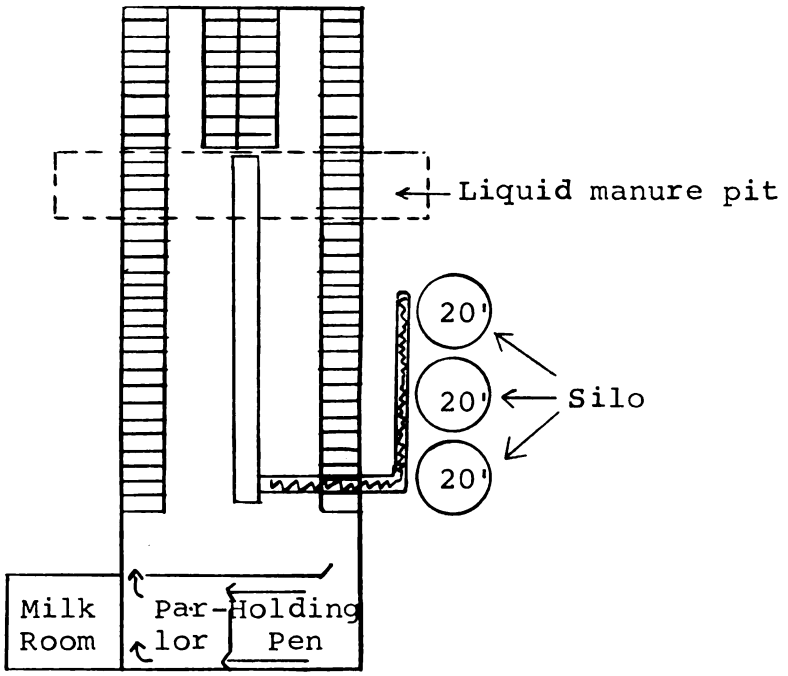

Figure 3. Eighty cow warm-enclosed free-stall barn. Similar plan to Figure 2, except here walls and ceiling are insulated and mechanical ventilation has been installed. Conditions in barn can be controlled regardless of outside conditions.

Selection of Farms for Study

By the summer of 1966 several cold-covered and warm-enclosed free-stall dairy barns had been recently built in the state of Michigan. There were many open-lot free stall operations, some of which had been built recently and others that had been operating for some time. In order to compare labor requirements and operating advantages of outside silage feeding with silage feeding in the barn eight free-stall barns were selected where silage was fed in the barn. Five of the eight selected were cold-covered free-stall barns while the remaining three were warm-enclosed free-stall systems. The eight selected farms were widely scattered over the state. Climatic conditions vary greatly in Michigan with the winters becoming more severe as one travels from south to north in the state. Such a scattering of the selected farms was desirable because it allowed observations to be made on the same kind of barns when used under different climatic conditions.

County agents assisted in locating eight open-lot free-stall systems to compare with the previous eight farms selected. Attempts were made to select only new installations of comparable herd size in the same general locality.

The farms where silage was fed outside are designated by the numbers 1 to 8, while those which fed silage in the barn have letters A through H. Throughout this thesis the

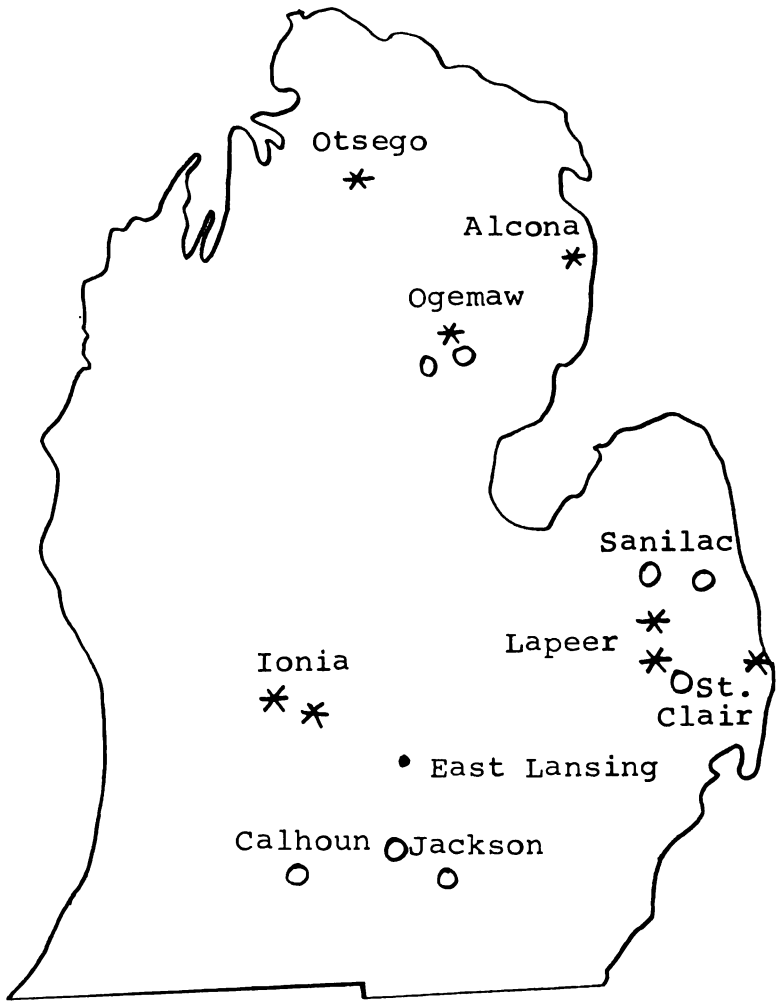

Figure 4. Location of farms.
*Farms where silage was fed in the barn.
OFarms where silage was fed outside in the yard.

farms in this study will be referred to by these letters and numbers.

Table 1. Herd size of selected farms

Outside Feeding	Number of Cows	Inside Feeding	Number of Cows
Farm 1	50	Farm A	50
Farm 2	65	Farm B	60
Farm 3	70	Farm C	60
Farm 4	70	Farm D	65
Farm 5	80	Farm E	70
Farm 6	110	Farm F	80
Farm 7	115	Farm G	95
Farm 8	120	Farm H	115

The farms where silage was fed in the barn tended to have slightly smaller herds than those which fed silage outside, but in general it was felt that the two groups were comparable with respect to cow numbers.

Besides comparing inside and outside feeding the farms were also chosen to evaluate liquid and conventional manure handling systems for both inside and outside feeding systems.

Table 2. Manure handling system

Outside Feeding			Inside Feeding		
Farm	Number of Cows	Manure System*	Farm	Number of Cows	Manure System*
1	50	Con.	A	50	Con.
2	65	Con.	B.	60	Liq.
3	70	Liq.	C	60	Liq.
4	70	Liq.	D	65	Liq.
5	80	Con.	E	70	Liq.
6	115	Liq.	F	80	Con.
7	120	Con.	G	95	Con.
8	125	Con.	H	115	Liq.

*Con. = conventional manure handling; Liq. = liquid manure handling.

In this study four different comparisons were made to evaluate conventional and liquid manure handling under both inside and outside feeding conditions.

1. Liquid and conventional manure handling for inside feeding.
2. Liquid and conventional manure handling for outside feeding.
3. Liquid manure handling for inside and outside feeding.
4. Conventional manure handling for inside and outside feeding.

Table 3. Number of farms according to feeding arrangement and manure handling system

	Outside Feeding	Inside Feeding
Conventional manure handling	5	3
Liquid manure handling	3	5
Total	8	8

Farm Visits

The 16 farms selected for this study were visited during the month of August 1966 when the objectives of the project were explained to the owners. All agreed to cooperate in the project and supply any information which would be required. One day a month from August through February was spent on each farm. It was customary to go to the farm in mid-afternoon and to remain on that farm until the evening chores for the milking herd had been completed. The following morning was spent on the same farm until one complete day's operation had been observed. At each visit the different daily chores required to care for the milking herd were observed, timed, and recorded.

Chores which required 30 minutes or less were timed on a stop watch to the nearest half minute. Operations such as milking which are of longer duration were timed on a

wrist watch to the nearest minute. Often it was necessary to run two stop watches at the same time as two different chores were being performed simultaneously.

On each visit several interesting comments were made by the operator with regards to problems or successes he had experienced with dairy operation in the weeks since the last visit. Such comments and replies to particular questions were also on the back of each chore sheet. All operators were willing to discuss frankly weaknesses or strong points in their dairy operation. Many were anxious to have unbiased suggestions about their particular problems and future plans.

A sample of the chore sheet which was completed at each farm visit is shown in Appendix A.

At one visit during the study an attempt was made to be present when chores such as grinding feed and hauling manure were done. On many farms these are not regular chores but done every few days. Since manure handling requires considerable time on any dairy farms, each operator kept a record of the time spent loading and hauling manure for a period of three months. Operators also kept a record of the bedding requirements and the time spent putting bedding in the stalls. Eleven of the sixteen farms used sawdust for bedding while the remaining five farms used straw either chopped or baled for bedding. The recorded times for bedding included bringing the sawdust or straw to the barn

as well as placing the bedding in the free stalls. Sample sheets used by the operators to record manure handling and bedding operations on their particular farm are shown in Appendices B and C.

For each farm visit the milk sales slips for the previous month were recorded. The number of cows milking at the time of visit was also recorded. With this information the producing level of the herd could be calculated. A sample milk sales record for any one of the farms is shown in Appendix D.

RESULTS AND DISCUSSION

Collecting Cows to Holding Pen

When free stall housing and a milking parlor are used for handling the milking herd one of the first functions to be completed at chore time is that of collecting the milk cows into the holding area next to the parlor. On many farms this chore is performed by one man while in other cases it is a two man job. If dry cows and heifers have to be separated from the milking herd going into the holding pen this usually necessitates having two people. Most dairymen prefer to allow only milking cows to go through the parlor because they feel that other animals going through the parlor reduces milking time efficiency.

Table 4. Time required to bring cows to the holding pen when outside feeding is used

Farm Number	Number of Cows	Time/Milking (minutes)	Sec./Cow
1	50	9.0	10.8
2	65	11.6	10.7
3	70	9.3	8.0
4	70	23.4	20.0
5	80	6.2	4.6
6	110	13.4	7.3
7	115	12.0	6.3
8	120	7.6	3.8
Average		11.6	9.1

On a per cow basis farm 4 required the most time, almost double any other farm in the group, to bring cows into the holding area. The reasons for this extra time on farm 4 are three fold.

1. Cows had access to a 3 acre field which made it necessary to gather the milk cows over a larger area.
2. Dry cows and heifers had to be separated from the milk cows before going into the holding pen.
3. Design of the holding pen was such that cows could slip by without entering, especially when only one man was present.

Table 5. Time required to bring cows to the holding pen when inside feeding is used

Farm Number	Number of Cows	Time/Milking (minutes)	Sec./Cow
A	50	4.3	5.2
B	60	2.3	2.3
C	60	3.0	3.0
D	65	5.2	4.8
E	70	5.3	4.5
F	80	3.8	2.8
G	95	10.3	6.5
H	115	6.3	3.3
Average		5.1	4.1

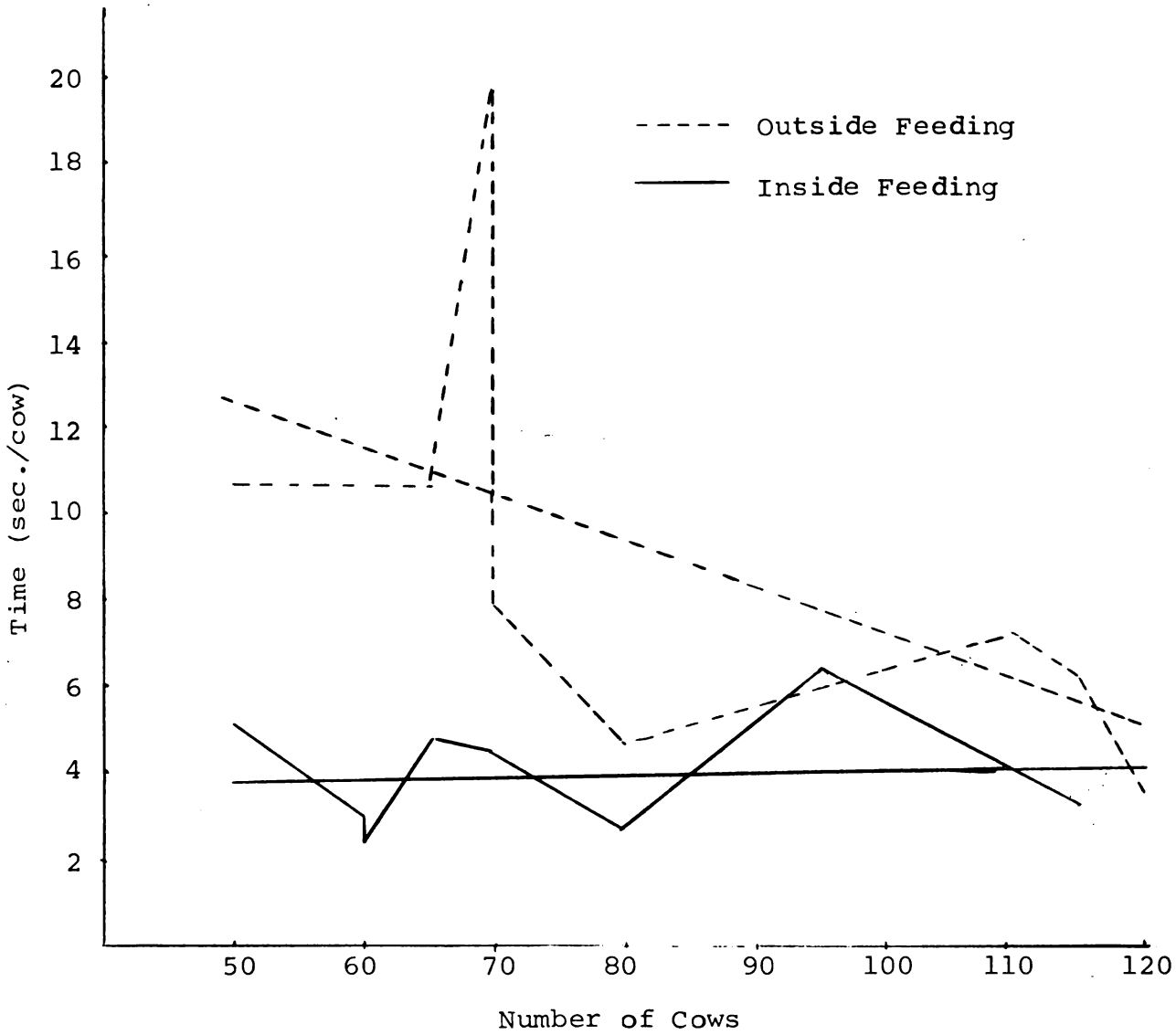

Figure 5. Time required to collect cows to holding pen.

Farm G required considerably more time to bring cows to the holding pen than did the other farms. This was due to too small a holding pen which was enlarged at each milking by using an extra gate temporarily joined to the holding pen gate. Even then it was difficult to squeeze all cows into the holding area. This procedure required two men and greatly increased the total time required to bring cows to the holding area.

Figure 4 depicts the time in seconds per cow which were required to bring the milking herd into the holding pen on the different farms. A simple linear regression line was applied to each group but when tested for the effects of scale neither was found to be significant. However, the results would indicate economies of scale are present when an outside feeding system is used. With inside feeding the results of this study suggest that size of herd above 50 cows had little if any effect on the per cow collecting time. The above graph shows it consistently took longer to collect cows which used an outside feeding system as compared with an inside feeding arrangement. The average time per milking for outside feeding systems was 11.6 minutes as compared to 5.1 minutes for the inside feeding group. On a per cow basis the outside feeding herds required 9.1 seconds as against only 4.1 seconds for the inside herds.

The reasons for differences in time to collect cows were:

1. In the open lot system cows had to be collected from a large area which in many cases included a 2-3 acre field as well as a paved barn yard.
2. With the covered system the cows are near the holding pen and at most had only to be brought the length of the barn.
3. Dairymen who used the open lot system more frequently ran dry cows and heifers with the milking herd and these had to be separated from the milking herd.

Preparing Milk Equipment

The preparation of milking equipment involves bringing the units from the milk house into the parlor and connecting the hoses to the milk and air lines. It is also necessary to switch the milk line from the wash tank to the bulk tank. A new filter or filters are installed the beginning of each milking. These filters are disposable and as such are replaced new for each milking. With most new installations the filters are placed either in the milk line near the bulk tank, or directly at the end of the line in the tank. Two of the sixteen parlors used a milking system where there was a separate filter for each milking unit. Often during the course of the milking these filters would become blocked and new filters would have to be installed

before milking could continue. Installations which used filters placed in the line seemed to be the most satisfactory as regards labor efficiency.

In most parlors small hoses with warm water were used to wash the cow's udder. Generally there was a means for automatically adding a small amount of disinfectant to this water. Four of the farms used a pail with warm water plus disinfectant to wash cow's udder with either a sponge or a cloth. It was necessary to get clean water several times during the course of a milking because water quickly became cool and dirty. The hose system required more water but it was a more sanitary and satisfactory method of washing cows prior to milking.

The different times required to prepare equipment for morning and evening milkings were recorded for each visit. On most farms there was little difference between the two milkings as to the time required. However on two farms the units were not removed from the parlor at night. This meant that a much shorter preparation time was required in the morning.

One half of the farms in the study used a double four herringbone milking parlor. The average time required to prepare milking equipment was 6.3 minutes in the morning and 7.0 minutes at night. On these eight farms there was little difference between the morning and evening times, nor was there a great difference between farms. The preparation

of the dairy equipment accounts for only a small percentage of the overall chore time.

Table 6. Preparing milking equipment

Farm	Parlor	A.M. (minutes)	P.M. (minutes)
1	D-4H*	5.5	5.6
3	D-4H	8.3	11.0
5	D-4H	7.0	8.8
8	D-4H	5.8	5.2
C	D-4H	7.8	7.2
E	D-4H	4.8	5.5
F	D-4H	5.4	4.5
G	D-4H	5.5	8.0
Average	D-4H	6.3	7.0
2	D-6H	14.7	15.6
7	D-6H	10.6	9.8
Average	D-6H	12.6	12.7
H	D-8H	12.0	12.8
6	D-8H	3.2	12.0
Average	D-8H		12.4
A	D-3H	5.6	5.5
D	Single 4 side opening	10.3	5.3
4	Single 4 side opening	3.2	9.3
B	Double 2 side opening	6.2	7.8

*D-4H: double four herringbone parlor.

With the two farms where double six herringbone parlors were used it required approximately twelve and a half minutes to set up milking equipment. This was about double the time of the farms which used double four herringbone parlors. Here both morning and evening preparations required close to the same time.

Farms 4 and 6 used a double eight herringbone milking parlor. The morning preparation of milking equipment on farm 6 required only about one-quarter as long as that required at night. This was due to the fact that following the evening milking on this farm the milking units were rinsed and left in the parlor over night. This meant that in the morning the units were already assembled in the parlor. Farms with double eight herringbone parlors also used approximately 12.5 minutes to assemble equipment. All herringbone parlors in this study used one unit for every two stalls.

Only one farm in the study used a double three herringbone parlor, and the set up time was about 5.5 minutes for each milking. This was in line with the double four herringbone parlors.

On farm 4 the milking units were not removed from the parlor after the evening milking and this again accounts for the short preparation for the morning milking.

One farm had installed a double two side opening parlor. In this parlor four milking units are used and the

preparation time is comparable to other parlors using the same number of units.

The preparation time for milking equipment was small, regardless of the type of parlor when compared to the total time spent with the dairy herd. On all farms the equipment was handy and supplies convenient so that the amount of travel and time were kept to a minimum. With one trip from the milk house to the parlor, the operator on farm 5 was able to take all four units. This man made only one trip between milk house and parlor either when setting up equipment to milk or taking it from the parlor after milking.

Milking

From both a labor and financial standpoint, milking is the most important chore on any dairy farm. Several different types of parlors were used on the farms involved in this study. The double four herringbone, which is one of the more popular types of parlors in Michigan, was used on eight of the study farms. Some of the less common parlors appeared on only one or two farms in the project. This was too small a number to base any conclusions on, but these results are in line with what other researchers have found.

Table 7. Milking parlor rates

Type	Number of Farms	Cow/Man/Hr.	Range	Cows/Hr. Thru Parlor
D-4H	8	38	24-43	38
D-6H	2	27	25-29	54
D-8H	2	35	34-35	68
D-3H	1	32	32	32
Single 4 side opening	2	28	22-33	28
Double 2 side	1	33	33	33

The results of the above table indicate that the double four herringbone is the most efficient kind of parlor from a labor standpoint. Even with this efficient parlor there was wide variation from farm to farm as noted by the range which went from a low of 24 to a high of 43 cows milked per man hour. Such a wide range emphasizes that the rate of milking is dependent upon several factors other than the type of parlor. Even with this mechanized machine milking the success of the system is still greatly dependent on the operator himself. The results for the double four herringbone parlor are computed with one man milking in the pit. Occasionally with some of these parlors there would be two men working in the pit. This was a waste of man power because it appeared that one man could satisfactorily operate a double four herringbone parlor.

The double eight herringbone parlor which is always a two-man operation was second to the double four in labor efficiency. Such a parlor works well with larger herds, over a hundred cows, but here it is essential to have two milkers who can work together smoothly.

The double six herringbone, which may be considered as a one- or two-man operation, is fairly common on many Michigan dairy farms. Some dairymen with herds in the 100 cow range have installed this size of parlor. These dairymen think that the one man double 4 parlor takes too long to milk a herd of this size. Yet they are hesitant to install a double eight because they fear it may be more than what two men can handle satisfactorily. The double six is preferred over the double seven because many grain feeders are designed to supply feed to two stalls. Results from this study suggest that of the six types of parlors studied the double six herringbone was the least efficient on the basis of cows milked per man hour.

Only one farm was using a double three herringbone and the results here were in line when compared with the results of the double four herringbone.

Three parlors in the project were designed to handle cows individually rather than as groups as does the herringbone. Two of these were single 4 side opening and the other was a double 2 side opening. The single 4 side opening parlor ranks low on cows milked per man hour. In addition, the

operator works harder in this type parlor because of the great amount of walking that is required to attend to 4 units, as compared to double 4 herringbone. After observing these dairymen milk, it appeared that a system requiring less walking such as a double four herringbone would be a more desirable one-man operation than the single 4 side opening parlor.

For the dairyman who wishes to milk cows individually the double 2 side opening parlor seems more efficient than a single 4 side opening one for two reasons. First, it appears to be more efficient in cows milked per man hour and second, the operator does much less walking while attending to 4 units. Other researchers have found total distance walked in milking 50 cows to be from 50 to 150 percent more for in-line side opening parlors than in the herringbone.

Although the double 4 herringbone appeared to be the most satisfactory type of parlor, the results varied greatly from farm to farm for this kind of parlor. During the course of the study it appeared that several factors can influence the rate of milking with any type of parlor.

First cows must come into the parlor reasonably well on their own to have efficient milking. To achieve this it is important that the holding pen be properly designed. Too often in new dairy operations, the rest of the set-up has been carefully designed but the end result at best is an enclosure in the corner of the barn near the parlor to hold

the cows. It fails miserably to fulfill its primary purpose that of funnelling the milk cows into the parlor in an efficient manner.

The holding pen on each of the 16 farms was different and after observing the milking on each farm several times it became apparent that to design a good holding pen certain principals must be adhered to. The following guidlines are some which bear consideration when designing or building a holding pen.

1. Holding pen should be the same width as the parlor and in essence is a continuation of the parlor itself.
2. Parlor stalls and holding pen should be on the same level so that there are no steps for cows to climb when entering the parlor. Holding pens built outside could be about four inches lower than parlor to prevent water, snow, or slush from entering the parlor.
3. For cows entering the parlor there should be a door for each side of the parlor. This allows cows to go straight to their stall avoiding turns and crossing over, both of which will slow up the entry of cows into the parlor.
4. In larger herds, above 50 cows, there should be gates in the holding pen which can be closed or pulled up

behind the cows to decrease its size after part of the herd has been milked.

5. A door from the parlor pit into the holding pen is an added feature which permits operator to go directly from the pit into the holding pen without using one of the cow entrance doors.
6. The above described holding pen could easily be equipped with a moveable gate which is mechanically powered to keep cows moving toward the holding pen. None of the study farms used any mechanical means to move cows in the holding pen and only two of the farms used gates to reduce holding pen size after part of the herd had been milked.
7. Many dairymen say the amount and type of grain fed in the parlor has much to do with how well the cows enter the parlor. Others refrain from putting silage in the bunk past noon so that cows will be somewhat hungry at milking time. Then the cows are more anxious to come into the parlor to get their grain. No doubt such management practices will have a bearing on how well cows enter the parlor. However as the trend continued to feed more grain in the silage bunk and less or in some cases none in the parlor the need for a properly designed holding pen becomes more critical. Six of the farms studied

fed at least part of their total grain ration in the bunk, and one of these fed no grain at all in the parlor.

The type of milking system and how well cows enter the parlor are only two of the several factors which affect the milking rate. The success of any milking system is dependent to a large degree on the dairyman working in the parlor. After several observations of different dairymen it was apparent that many dairymen over the years have acquired habits in milking which reduce the overall milking efficiency. The following list will illustrate some of the things operators do while milking. In most cases these are unnecessary or should not be required with the proper management of a dependable system.

1. Operators coming out of pit
    a. To inspect grain feeders.
    b. To knock grain down in feeders.
    c. To scrape manure out of stalls.
    d. To get antibiotics to treat a cow.
    e. To get a bucket for milking a fresh cow.

The man working in the parlor pit is comparable to a worker on an assembly line in the car plant. Both have to stay at their posts to get the job done. The milking operator cannot milk cows if he is not in the pit. The most efficient farmer of the group of 16 visited rarely ever

comes out of the pit once he has started milking until he was finished. At each visit he milked over 100 cows with a double four herringbone.

2. Operators who spent extra time to wash cows. More washing than was necessary for sanitary purposes.
3. Too long machine stripping.
4. Stripping cows by hand.
5. Dipping teats on each cow with a disinfectant after milking.
6. Washing teat cups off after milking each cow.
7. Dipping teat cups in a disinfectant after milking each cow.

Some of the tasks connected with milking, a dairyman may want to perform for sanitation purposes, or depending on the health rules of his area the dairyman may be obliged to perform them. However the main point of this discussion is to emphasize the importance of eliminating all unnecessary tasks not required in milking. Each extra chore performed will likely decrease the number of cows milked per man hour.

Cleaning Milking Equipment and Milk House

Once the milking has been completed it is customary to clean the milking equipment and milk house. On most farms this chore took longer in the morning than it did at night, because the equipment and building were cleaned more thoroughly in the morning than they were at night.

First the milking units are removed from the parlor to the wash tanks in the milk house. Depending on the operator these units may be first washed by hand and then placed on the wash rack or they may be placed directly on the wash rack. The milk line is disconnected from the bulk tank and the filter removed. This line is then swung to the wash tank and connected in preparation for the wash cycle. Nine of the farms had washing equipment which was controlled automatically whereas on the other seven farms the wash cycle was controlled by manual switches. When the milking equipment was prepared for washing it was customary to clean the milk house at the same time. Usually the milk house was cleaned by washing the floor and the lower part of the walls with a hose.

For the eight farms which used double four herringbone parlors the average cleaning times for equipment and milk house were approximately 15 minutes in the morning and 10 minutes at night. Two of these farms had automatic washing equipment. One of these had the shortest clean up time both morning and evening while the other had the longest morning clean up time and was also above average for the evening time. These eight farms with similar parlors on the average took 50 percent longer in the morning than at night.

Table 8. Cleaning milking equipment and milk house

Farm	Parlor	A.M. (min.)	P.M. (min.)	Type of Washing Equipment*
1	D-4H	17.7	6.0	Manual
3	D-4H	23.5	12.5	Automatic
5	D-4H	9.2	5.6	Automatic
8	D-4H	13.5	11.4	Manual
C	D-4H	15.1	5.8	Manual
E	D-4H	11.9	10.9	Manual
F	D-4H	18.7	16.0	Manual
G	D-4H	11.5	12.6	Manual
Average	D-4H	15.1	10.1	
2	D-6H	13.4	11.5	Automatic
7	D-6H	24.3	19.2	Automatic
Average	D-6H	18.8	15.3	
6	D-8H	21.2	6.2	Automatic
H	D-8H	20.0	12.4	Automatic
Average	D-8H	20.5		
A	D-3H	21.4	13.4	Manual
D	Single 4 side opening	15.2	7.7	Automatic
4	Single 4 side opening	27.6	3.7	Automatic
B	Double 2 side opening	21.3	7.0	Automatic

*Manual: manual, where operator controlled each phase of the washing cycle. Automatic: automatic, where the operator only started the washing cycle.

The two farms with double six herringbone parlors both had automatic washing equipment, and the average clean up times were approximately 19 and 15 minutes for morning and evening respectively. However, there was considerable difference in the length of time required on the two farms. The main reason for this difference was that on farm 7 the units were washed by hand before being placed on the wash rack, whereas on farm 2 they were placed immediately on the wash rack.

Both farms with double eight herringbone parlors required about 20 minutes to clean in the morning. At night farm 6 took only 6.2 minutes to clean up equipment and milk house because the units were only rinsed and left in the parlor.

Farm 4 was another case where the milking units were rinsed and left in the parlor over night, which accounts for the short evening clean up time.

Clean up time may be more closely related to methods employed by the operator than it is to the type of parlor or washing equipment. All operators did a satisfactory job which appeared at least adequate, to meet the standard set for Grade A milk production. New milking equipment with inplace machine washing does a good job of cleaning when used according to manufacturers directions with the proper kinds and amounts of detergents and sanitizers.

None of the clean up time previously discussed includes the cleaning of bulk tanks which were used on all sixteen farms. Four of the farms had bulk tanks with completely automatic washing facilities. After the truck driver had emptied the milk from these tanks he started the cycle to wash and sanitize the tank thus requiring no time on the part of the farmer for cleaning. On two farms the farm tanks were washed inside and out by the truck driver so that the tanks were ready for the next milking. This was an extra service provided by private haulers who apparently were anxious to attract new customers. On one farm a portable unit was used to wash the bulk tank. Although such a unit did save some work it did not save any time because the farmer stayed there while the washing was taking place. The unit required about the same length of time to wash the tank as those tanks which were washed by hand.

All the farms had originally been planned for every other day pick up of milk. Because of expanding production two farms had to have milk collected every day and some of the other herds had only storage capacity for one day's production at certain times throughout the year. The average time required for washing a bulk tank on farms where automatic washing equipment was not used was found to be 18 minutes per washing. Whether the bulk tanks were washed daily or every second day appeared to have little if any effect on the time spent washing the tank at each occasion.

Over a period of one year with every other day washing this amounts to approximately 55 hours per year or a total of 110 hours per year if the tank was washed daily. Depending on the price fixed for labor, the use of automatic washing equipment could amount to a considerable savings in money over a period of time. This is particularly true with larger herds and especially if milk is picked up daily. Besides the saving in time and money there is also an added convenience of not having to wash the tank during the day or just before the evening milking. On most farms the milk is picked up sometime during the day which means the tank cannot be washed when the other dairy equipment is being cleaned. As dairy operations become larger and more mechanized it is expected that more dairy farms will have bulk milk tanks supplied with automatic washing equipment.

Cleaning the Milking Parlor

Cleaning the parlor is another chore which is usually done immediately following the completion of milking. On some farms cleaning the milking equipment and cleaning the parlor was performed simultaneously. When two people were used for the milking operation, it was customary for one to take care of the milking equipment while the other cleaned the parlor. Even in one man parlors, another member who had been doing outside chores might come in to clean the parlor while the other cleaned the dairy equipment.

Dairymen who used a liquid manure system had the drains from the milk house and parlor emptying into the manure pit. Such an arrangement fulfilled a double purpose. First it provided a disposal place for waste water from the parlor and milk house. Secondly, extra water was usually needed in the manure pit to bring the manure to a consistency which can be easily handled with a liquid manure pump. When cleaning the parlor on these farms it was usual to wash waste grain, manure and dirt down the drain with a hose.

Dairymen who did not have a liquid manure system followed a somewhat different procedure when cleaning the parlor. On these farms the grain which cows had spilled on the floor was scraped up and put back in the feeders or into a pail or container. The manure was scraped up and carried out before the parlor was hosed down. With this system more care had to be exercised to prevent drains and septic tanks from becoming plugged with waste grain and manure or filled with excess water.

On two of the farms, this waste grain from the parlor floor was fed to a group of pigs. This grain plus milk unfit for sale from the parlor was the only feed used to market two groups of 4 hogs each twice a year. The farmers felt the sale of these pigs was a net profit because they were raised on waste materials from the milking parlor which would have otherwise been thrown out.

Several of the dairymen had installed small auxilary electric pumps for washing down the parlor. These appeared to be a good investment since they greatly increased pressure which facilitated cleaning the parlor.

All sixteen farms maintained a reasonable degree of cleanliness in their parlors and satisfactory to meet Grade A milk requirements. Some operators had their parlors very clean at all times while others were content to do only minimum cleaning. It is quite possible that parlor cleaning time is more closely related to the kind of operator rather than to the type of parlor and its cleaning facilities. As with cleaning the milking equipment most dairymen in this study did a more thorough job of cleaning the parlor in the morning than at night.

The morning cleaning times ranged from 5.7 to 30.2 minutes for farms with a double four herringbone parlor. At night the range was between 3.6 and 16.0 minutes. The morning and evening average cleaning times were 13.9 and 9.8 minutes respectively for this type of parlor.

The two double six herringbone parlors had average cleaning times of 16.7 and 14.4 for morning and night respectively.

The parlor on farm 6 was always exceptionally clean which accounts for the longer cleaning time, particularly in the morning. Each morning all the metal stalls and feeders

were washed by hand. None of the other dairymen gave this type of regular care to the parlor equipment.

Table 9. Parlor cleaning times

Farm	Parlor	A.M. (minutes)	P.M. (minutes)
1	D-4H	30.2	7.9
3	D-4H	19.2	14.2
5	D-4H	8.8	8.3
8	D-4H	7.3	7.7
C	D-4H	5.7	3.6
E	D-4H	5.8	7.5
F	D-4H	24.0	16.0
G	D-4H	10.0	13.2
Average	D-4H	13.9	9.8
2	D-6H	13.3	11.0
7	D-6H	20.2	17.8
Average	D-6H	16.7	14.4
6	D-8H	44.2	17.5
H	D-8H	19.4	13.7
Average	D-8H	31.8	15.6
A	D-3H	11.6	9.3
D	Single 4 side opening	11.2	9.8
4	Single 4 side opening	23.7	0.0
B	Double 2 side opening	10.0	8.4

On farm 4 no cleaning was done in the parlor after the evening milking and as a result the morning cleaning took considerably longer than other parlors in this group.

Results from these farms would indicate that in general, dairymen spend more time cleaning their milking parlors in the morning than at night. There are two reasons for shorter cleaning times at night. First, there is little chance of the health inspector seeing the parlor between the evening and morning milkings. Second, after the evening milking dairymen are anxious to complete their day's work and so many are prone to cut corners.

The larger double six and double eight herringbone parlors required slightly longer time to clean than the double 4 herringbone. This is to be expected since there is a bigger area and more stalls and feeders to clean. The extra cleaning time required for the larger parlors was not great and when cleaning time is computed on cow capacity these larger units make more efficient use of labor.

Feeding Silage

The farms in this study used either corn silage or haylage as their main forage for their milk cows. On five farms the milk cows received no dry hay. Most of the operators fed only a small amount of hay and many indicated their future plans called for the elimination of dry hay from their forage feeding program. Generally those who fed

hay did so because they did not have adequate storage to provide an all silage ration to their herd.

Tower silos of either poured concrete, cement stave, or glass lined construction were used for silage storage on the 16 farms. Some dairymen used a combination of concrete and sealed storage.

Silo facilities for each farm are shown in Appendix E.

Mechanical unloaders were used to remove silage from the silos and feed it to the cattle. Different feeding systems were used to distribute silage in the bunk, and all appear to work reasonably well. Although augers have been used extensively in the past they are high upkeep systems and the trend appears to be to other feeding arrangements which have lower operating costs.

There was no significant difference in time spent feeding silage per cow for the two groups of farms (see Table 10). All operators who fed silage in the barn supervised the operation while only three in the other group supervised the silage feeding. Seventy-five percent of the farms with inside silage feeding fed extra grain in the bunk and this partially accounts for larger number of dairymen who oversaw this process.

Of those with outside silage feeding only one fed any grain in the bunk. When grain is being added to silage

Table 10. Silage feeding time

Farm	Times/Day	Minutes Feeding/Day	No. Fed	Min./Animal	Extra Corn in With Silage	Supervised
1	3	50	70	0.71	No	No
2	2	40	70	0.57	No	Yes
3	4	93	90	1.03	No	No
4	3	97	90	1.08	No	Yes
5	3	60	80	0.75	No	No
6	3	50	125	0.40	No	Yes
7	2	50	120	0.42	No	No
8	4	32	120	0.27	Yes	No
Average				0.65		
A	2	40	50	0.80	Yes	Yes
B	3	55	70	0.79	Yes	Yes
C	3	90	65	1.38	No	Yes
D	3	35	65	0.54	Yes	Yes
E	3	50	70	0.71	Yes	Yes
F	3	40	80	0.50	No	Yes
G	3	35	100	0.35	Yes	Yes
H	3	45	120	0.37	Yes	Yes
Average				0.68		

there is more need for supervision and often some hand labor is required with the grain handling.

Although the averaged required time to fed silage per animal was close for both groups, there were large variations from time to time on the same farms. Some of the reasons for these variations were as follows:

1. Running two silo unloaders instead of one when feeding.
2. Corn silage fed out easier and faster than haylage.
3. Fineness of cut affected unloading rate.
4. Moisture content was also a factor in unloading rate. Silage and particularly haylage with a high moisture content is more difficult to dig out of a silo.
5. On some farms the time spent feeding silage varied throughout the year because of other changes in feeding program. Such changes include increases or decreases in dry hay feeding as well as some supplemental green chopping in summer.

Some tasks which were accomplished while silage feeding system was running were:

1. Removal of droppings from free stalls.
2. Milking.
3. Feeding dry hay.
4. Scraping barn yard.
5. Cleaning parlor.

When silage feeding had to be supervised it was very time consuming. Many farmers were hesitant to leave equipment running unattended because of costly breaks and ruined belts which have occurred in the past. Better safety devices and control switches could eliminate many such breaks. One feeding system featured a timing device which could be set for any length of time to automatically shut the system off after running for a set number of minutes. Future developments in cattle feeding will likely incorporate such labor saving devices.

Hay Feeding

Five of the sixteen farms fed no dry hay and depended entirely on silage for their forage program. However, on each of the farms a portion of the silage fed was haylage. The remaining 13 farms fed hay but in most cases it was only a limited amount to supplement the silage feeding. The three different hay feeding systems that were used were:

1. Hay stored in old dairy barn and fed in an adjacent hay rack.
2. Hay stored in one story pole barn and fed at a moveable front manger.
3. Hay stored in another barn and hauled as needed to be fed inside covered free-stall barn.

Labor requirements for feeding hay on the different farms is given in the following table.

The most efficient hay feeding system was where the hay was stored in a pole building and fed by a moveable front manger. The average feeding time on the four farms using this system was 7.5 minutes per day. When the manger was moveable, it could be kept close to the hay which eliminates long carrying distances.

Often dairymen wish to utilize existing barns for hay storage and feed hay in a rack along the barn. Two farms in the study used this system and they each spent 16 minutes a day or slightly more than twice as long as when a regular hay barn was used.

The most inefficient method was found to be where hay was stored in another barn and hauled as needed to be fed in a bunk in the free stall barn. Operators using this arrangement spent on the average 28 minutes per day which is approximately four times as long as those who used a regular hay barn. On farms where silage is fed inside the barn no provision is made for storing or feeding dry hay. The hauling of hay to feed in covered housing indicated the system does not effectively or efficiently function with dry hay as a part of the feeding program. All such housing systems in the study are relatively new and hay was fed because of habit or to supplement the forage program because of insufficient silo capacity. The feeding of hay on such farms was

Table 11. Hay feeding time

Farm	Hay Fed	Storage	Feeding Area	Times/Day	Total Time Min./Day
1	Yes	old dairy barn	rack along barn	4	16
2	Yes	old dairy barn	rack along barn	2	16
3	No	...	...	..	..
4	No	...	...	..	..
5	Yes	pole barn	front hayrack	2	7
6	Yes	pole barn	front hayrack	1	5
7	Yes	pole barn	front hayrack	2	8
8	Yes	pole barn	front hayrack	2	10
A	Yes	barn 1/2 mile	free-stall barn	2	25
B	No	...	...	..	..
C	No	...	...	..	..
D	Yes	barn 200 yd.	free-stall barn	2	45
E	Yes	barn 400 yd.	free-stall barn	2	25
F	Yes	barn 100 yd.	free-stall barn	2	20
G	Yes	barn 1/2 mile	free-stall barn	2	25
H	No	...	...	..	..

very inconvenient and it is expected that most will eventually eliminate it from the feeding program.

Labor Requirements for Bedding

The introduction of free-stalls for the milking herd has greatly altered the bedding pattern. Bedding has ceased to be a daily chore and now is performed at intervals of one week to one month or even longer under certain conditions. Several different types of bedding material can and are being used successfully. Straw was used on five farms while the remaining eleven used sawdust. Both appear to work well. However, if straw is used for bedding with a liquid manure system, then the straw must be chopped. With conventional manure handling baled straw is satisfactory.

Either straw or sawdust was used for bedding on the 16 farms. Five of those with outside feeding used straw while only one in the other group used straw for bedding. There were five cases of baled straw and one of chopped straw.

Most dairymen who used sawdust obtained it at a nominal fee from a local saw-mill. At certain times of the year farmers in some areas of Michigan have difficulty in obtaining sufficient sawdust for their free-stalls. One farmer had a truckload of sawdust delivered to his farm each month for twenty-five dollars. With more free-stalls being built and actually fewer saw-mills operating, both the

demand and price of sawdust will increase considerably in the future. Many dairymen are already experiencing difficulties in buying sawdust.

Table 12 shows the time each dairyman spent bedding the free-stalls. Times include hauling the sawdust or straw to free-stalls but doesn't include the harvesting of straw or hauling it from the field.

Table 12. Bedding time

Farm	Number of Stalls	Bedding		Monthly	
		Kind	Frequency	Hours	Min./Stall
1	80	straw	weekly	6.0	4.5
2	82	sawdust	monthly	8.0	6.0
3	77	sawdust	monthly	4.0	3.1
4	78	sawdust	monthly	3.0	2.7
5	80	straw	weekly	6.0	4.5
6	135	straw	monthly	4.0	1.7
7	108	sawdust	trimonthly	3.0	1.7
8	120	straw	monthly	1.5	0.75
					$\bar{X}$ 3.12
A	50	straw	weekly	4.0	4.8
B	74	sawdust	biweekly	5.0	4.1
C	65	sawdust	monthly	5.0	4.6
D	62	sawdust	bimonthly	5.0	5.0
E	78	sawdust	every 6 wks.	4.0	3.1
F	94	sawdust	weekly	9.5	6.0
G	94	sawdust	monthly	12.0	7.6
H	139	sawdust	monthly	12.0	5.2
					$\bar{X}$ 5.1

Results of this study indicate farmers with an outside feeding system spent less time bedding the free-stalls than those in the other group. Average times were 3.1 minutes as against 5.1 minutes per stall per month. On a per stall basis Farm 8 spent the least time bedding. Here the baled straw was stored directly over the stalls which made it very convenient for bedding. Dairymen with inside feeding systems spent on the average 63 percent more time bedding than those who fed in the yard.

Some factors which affect the amount of time spent bedding are:

1. The frequency of putting in new bedding.
2. Type of bedding material used.
3. Location of bedding material.
4. The ease with which bedding material can be handled in the barn.
5. The standard of cow comfort and cleanliness demanded by owner.

Most of the farms with outside feeding systems provided a 2-3 acre lot for their cows. This meant that during the summer the cows spent considerable time here and less in the free-stall barn. These dairymen spent less time in summer bedding their barns. Also two of the farms in this group had the straw stored in the free-stall barn which helped to reduce the bedding time.

Manure Handling

Scraping.--Small farm tractors with three point hitch blades attached on the back were used to scrape the free-stall alleys and the barn yards. These small tractors usually in 2-3 plow size were very maneuverable and yet have sufficient power to perform the job. It is desirable to have wings on the ends of the blade because this will make the scraping of sloppy manure easier and faster.

The covered free-stall barns were usually scraped daily; however, some dairymen in this group scraped twice a day while another scraped only every second day. Daily scraping seems the best and most accepted practice for covered housing. When outside temperatures fell to zero and below the manure in these cold covered barns became frozen and very difficult to scrape. Such manure should not be put into a liquid manure tank. When this kind of weather conditions occurred farmers did not attempt to scrape the alleys but left them until the weather moderated. There appeared to be no problem even when alleys were left four or five days. As long as the manure was frozen the cows remained clean and comfortable and when the manure thawed, it could be easily handled.

The manure handling time on each farm was divided into two sections--a scraping time and a loading and hauling time. The scraping time included cleaning the free-stall alleys and the paved lot if part of the system. Cleaning

the holding pen was also included in this section. Some holding pens were cleaned with the tractor, while others were scraped by hand or hosed down with water. The removal of droppings from the stalls was not included in the scraping time and will be discussed under a separate section.

This data on cleaning times was collected during fall and winter months when animals are confined to either enclosed barns or paved lots as the case may be. The cleaning times for any housing system can be altered greatly during the summer if the cows have access to open areas which are not scraped. It was felt by collecting this data when cattle were confined most of the time would give a better comparison of the different housing systems. A scraping time was obtained at each monthly visit. The time spent loading and hauling manure, however, was recorded by the cooperator when these jobs were performed.

The distance the manure was hauled had a significant bearing on the total manure handling time. An attempt was made to equalize this hauling time especially when extreme distances either long or short were involved. Over a period of time it was found that generally these distances average out on any one farm.

Some of the farms with conventional manure handling arrangements hauled manure daily to the field while others had small storages which held from three days to a week's

collection. Many preferred to take out several loads at one hauling rather than one or two loads every day. Operators using liquid manure had storage capacities for their herd ranging from 2 to 4 weeks time. All of these dairymen stated the need for greater storage capacity at particular times of the year. Deep snow in winter and soft ground in spring are two times of the year when it may be impossible to get on the fields to spread manure. As we approach these seasons of the year, dairymen attempt to have their manure tanks relatively empty so as to have maximum storage time. During the winter of 1966-67 unusual heavy snowfalls were experienced in certain parts of the state. There was one case where the tank became full and had to be emptied, even though it was impossible because of the snow to go into the fields. Then the liquid manure was hauled and dumped in a spot in the field. Little value will be realized from this manure but this dairyman had no alternative.

Table 13 shows the time in minutes scraping manure per day on each of the 16 farms. In order to compare scraping times on the different farms the times were expressed as minutes per stall per day. The average scraping time for the two groups of farms were very similar with only a difference of .01 minutes per stall per day. However, if all farms in the letter group scraped their barns daily then the average times were .50 and .39 minutes per stall per day. This is a difference of .11 minutes per stall per day.

Table 13. Labor requirements for manure handling

Farm	Number of Stalls	Scraping			Loading and Hauling		Total Cleaning Time/Stall/Day
		Frequency	Min./Day	Min./Stall /Day	Min./Day	Min./Stall /Day	
1	80	daily	35	0.44	30	0.38	0.82
2	82	daily	36	0.44	40	0.49	0.93
3	77	daily	54	0.50	40	0.52	1.02
4	78	daily	68	0.87	40	0.51	1.38
5	80	daily	33	0.41	63	0.79	1.20
6	135	daily	45	0.33	50	0.37	0.70
7	108	daily	56	0.52	50	0.46	0.98
8	120	daily	55	0.46	60	0.50	0.96
Average				0.50			1.00
A	50	daily	32	0.64	75	0.67	1.31
B	74	twice daily	53	0.72	32	0.43	1.15
C	65	daily	17	0.26	19	0.29	0.55
D	62	every other day	20	0.32	20	0.32	0.64
E	78	daily	35	0.45	22	0.28	0.73
F	94	twice daily	56	0.60	40	0.43	1.03
G	94	twice daily	64	0.68	75	0.80	1.48
H	139	daily	36	0.26	32	0.23	0.49
Average				0.49			0.92

$\overline{X}$ = 0.39 - average scraping time for this group of farms (A-H) when all barns were scraped daily.

Farm 4 had a scraping time of .87 minutes per stall per day. This high rate was due mainly to a large enclosed holding pen which could not be cleaned with the tractor and blade but was scraped by hand.

Loading and hauling manure was recorded as minutes per day but like scraping for comparison was converted to minutes per stall per day. Time spent loading and hauling manure ranged from a low of .29 to a high of .80 minutes per stall per day.

The last column in Table 13 gives the total time in minutes per stall per day for handling manure on each of the farms. The most efficient time was .49 minutes while the least efficient was 1.48 minutes. On a per stall per day basis Farm G spent about three times as long handling manure as Farm H did. Total cleaning time per stall per day for the outside and covered systems was 1.00 and .95 minutes, respectively.

Table 14 shows that dairymen with open lot free-stall housing and a conventional manure handling system spent on the average .98 minutes per stall per day removing manure. Here the manure from the free-stall alleys and paved yard was scraped into a pile. It was next loaded with a tractor into a spreader to be hauled to the field. The free-stall alleys were scraped daily on all these farms but the scraping of the yards varied from daily on some farms to every two weeks or longer on other farms. During this study

Table 14. Labor requirements for handling manure with outside feeding and conventional manure handling system

Farm	Scraping	Hauling	Total
1	0.44	0.33	0.82
2	0.44	0.49	0.93
5	0.41	0.79	1.20
7	0.52	0.46	0.98
8	0.46	0.50	0.96
Average	0.45	0.52	0.98

some of the above dairymen made a special effort to clean the yard every day so that there was no build up of frozen manure and snow. While others cleaned the yards only when there was mild weather so that the material on the yards began to thaw and become messy.

The size of barn in this group ranged from 80 to 120, but there was no evidence of economies of scale as one goes from the smaller to the larger unit.

All farms except number 5 had a small area for the storage and loading of manure. One reason for the longer hauling time on Farm 5 was the lack of a good place where one man could load manure. Here the procedure was to use two tractors when loading manure from the yard. One tractor with a bucket for loading and the other with a blade to assist in filling the bucket.

Table 15 indicates that farms with outside feeding and liquid manure pits in the yard spent 1.03 minutes per stall per day handling manure. For the fall months the liquid manure pits were used all the time, however, during the months of December, January, and February the pits were used only a small part of the time. The reason being that frozen manure or snow can not be put into a liquid pit. Only on mild days during the winter could manure be put into the liquid pit.

Table 15. Labor requirements for handling manure with outside feeding and liquid manure handling system

Farm	Scraping	Hauling	Total
4	0.87	0.51	1.38
6	0.33	0.37	0.70
3	0.50	0.52	1.02
Average	0.57	0.47	1.03

The results of this study showed little difference in labor requirements for manure handling when either liquid or conventional manure handling facilities were used with outside silage feeding. There are some indications that slightly less labor was required for loading and hauling. Had this study ranged over twelve months instead of a six month period the advantage of liquid manure for loading and

hauling might have been more pronounced. At certain times of the year when the consistency of the manure in the yard is such that it can best be handled in liquid form then liquid manure pits are very convenient.

One disadvantage of liquid manure pits in the yard is that heavy rains or sudden melting of snow will fill the pit with water requiring the farmer to spend time hauling it away. Also during dry summer weather the manure in the yard is too dry to work well in the pit.

Table 16 shows the farms with inside silage feeding and conventional manure handling facilities had an average total manure handling time of 1.29 minutes per stall per day. Although Farms C, F, and A were in the same group there were variations in their manure handling systems.

Table 16. Labor requirements for handling manure with inside feeding and conventional manure handling

Farm	Scraping	Hauling	Total
A	0.64	0.47	1.37
F	0.60	0.63	1.03
G	0.68	0.80	1.48
Average	0.64	0.63	1.29

On Farm G there was a large free area at one end of the barn where the manure was scraped into a pile. Then the spreader was brought into the barn and loaded by using a tractor bucket. In a free stall barn when the manure is very fluid, this system is slow and unsatisfactory.

Farm A had a regular gutter cleaner which ran across one end of the barn to the outside. Wooden covers were placed over the gutter. When cleaning, these covers were removed so that manure could be pushed into the gutter. Because the chain moved slowly, extra care and time were required to avoid pushing large amounts in at one time which blocked the cleaner. This system required four pieces of equipment: the tractor and scraper inside the barn, the gutter cleaner, the spreader and tractor outside at the end of the gutter cleaner. At any time of the year but particularly in cold weather extra time and labor are required to get all equipment operating.

Barn F was located where the slope of the land was just right so manure could be pushed over the edge of a lip into a spreader. On this farm the ramp could have been closer to the barn which would have reduced loading time. The loading ramp system is simple and works well where the location is suitable for building a ramp.

Table 17 indicates that farms with inside silage feeding and liquid manure facilities had an average total manure handling time of .71 minutes per stall per day or

Table 17. Labor requirements for handling manure with inside feeding and liquid manure handling

Farm	Scraping	Hauling	Total
B	0.72	0.43	1.15
C	0.26	0.29	0.55
D	0.32	0.32	0.64
E	0.45	0.28	0.73
H	0.26	0.23	0.49
Average	0.40	0.31	0.71

percent of those with conventional system. These operations appeared to be the most efficient in both scraping and hauling and as such they had the lowest total time of the four systems studied.

On these farms the liquid manure pit was under the barn and projected out past the barn on one or both sides. This arrangement minimized the scraping the distance because the manure from each alley was scraped directly into the pit underneath. Agitating and pumping was done from outside the barn.

Two of the farms had been using liquid manure for approximately two years, while the other three farms had been in operation about one year. All owners were pleased with this method of handling manure in an enclosed free-stall barn.

Some of the advantages and disadvantages of liquid manure listed by the owners were:

Advantages:

1. Convenience of not having to haul manure every day.
2. Ease of scraping alleys with pit under the barn.
3. Since there was no loss of liquids or solids with liquid manure, dairymen felt there was an increased fertilizer value over conventional manure handling.
4. Absence of flies and foul odors with this system.
5. Ease and speed of handling with the proper equipment. (Loading requires no work and a 1400 gallon spreader tank can be filled in 2-3 minutes.)
6. Pit can serve as a disposal place for waste water from parlor and milk room.
7. Liquid manure can be spread on hay ground immediately after one crop has been removed and no manure is picked up in the next cutting.
8. Less waste space in barn using liquid manure than with other systems.

Disadvantages:

1. High cost of equipment.
2. Available equipment unsatisfactory, especially earlier pumps on the market.
3. Having to empty the tank at inconvenient times.
4. Danger of getting too much sawdust or other coarse bedding materials in the tank.

Storage time on these farms ranged from 2 to 4 weeks and all mentioned the desirability of having greater storage capacity.

Table 18. Analysis of variance for total manure handling time

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Manure handling	1	.1732	.1732
Feeding arrangement	1	.0400	.0400
Interaction	1	.3731	.3731*
Experimental error	12	.6914	.0576

*Significant at 5% level.

As there was an unequal number of farms in each of the four different groups, a weighted squares of means procedure was used to determine whether there was a statistically significant difference between liquid and conventional manure handling (28). After it was determined that no significant differences existed between the different manure handling systems at the 5 percent level, the interaction between feeding arrangement and the manure handling system was found to be significant. In order to say which system of manure handling is the more efficient, one must know what kind of feeding (housing) arrangement we are referring to.

Table 19. Labor requirements for different manure handling systems

	Outside Feeding	Inside Feeding
Conventional Manure Handling	0.98*	1.29*
Liquid Manure Handling	1.03	0.71

*Minutes per stall per day.

Liquid manure with covered housing required the least time for manure removal of the four groups studied. This system required .27 minutes per stall per day less than conventional manure with outside feeding which was second in labor efficiency. On a 100-cow herd, this saving would approach one-half hour each day. The use of liquid over conventional manure handling for outside feeding did not appear to save any labor. Covered housing with conventional manure handling had the highest labor requirement.

Removal of Droppings from Free-Stalls

The time spent for the removal of droppings from free-stalls varied greatly from farm to farm. It was not included in the total manure handling time because there appeared to be no connection between time spent and the type of housing or manure system. The time spent doing this

chore is more dependent on the standards set by the dairyman than anything else.

The usual procedure is to walk along in the alley behind the stalls and with a rake remove any dropping from the stalls. On no farm did this require a lot of time and often it was done when the cows were being brought to the holding pen. Some dairymen inspect their stalls twice a day for droppings to be removed, while others perform this task only daily or even every second day. Results of this study would indicate that in a 100 cow barn going through the stalls twice a day one could expect to spend approximately 9 minutes per day.

Suggestions by dairymen for keeping stalls and cows cleaner were:

1. For Holstein cows free-stalls should not be longer than 7 feet.
2. Use of wither board installed properly at front of stall (5 feet from rear of stall and 4 feet above bedding).
3. Have bottom of stall properly filled with clay to within two inches from top of curb (clay is much superior to sand or gravel).
4. Keep stalls well filled with bedding. If stalls are well bedded, when cows get up they are more inclined to back out of their stall before defecating.

If the above suggestions were practiced, once a day would be adequate to go through stalls. For a 100-cow milking herd this would require 5 minutes or less per day.

Grain Handling

There were almost as many different ways of handling grain for the milking herd as there were farms. Because of the many variations it was impossible to group the farms by their grain handling system, or to compare the different methods for labor efficiency. However, during the study the advantages and disadvantages of the different systems were observed and these will be discussed later in this section.

The main ingredient in all grain mixes was corn in one of four forms: dry shelled or ear corn and high moisture shelled or ear corn. The grain handling facilities for each farm are presented in Table 6 of the appendix.

One farm fed only a mineral protein block in the parlor, while all other farms fed at least part of their grain ration in the parlor. Five other farms as well as the one previously mentioned fed grain in the silage bunk.

Some parlors particularly the older ones were two-story buildings with the grain being stored above the milking area. Here it required approximately 5 minutes daily to fill the feeders by hand.

On other farms the milking place was a one-story structure and grain was stored in a bulk bin next to the parlor. No labor was involved here because a moving chain

mechanism carried grain to the parlor always keeping the feeders filled. These bulk bins with a moving chain appeared to work well under different conditions even to conveying high moisture ground ear corn which was one of the most difficult grains to transfer.

Two operators trucked their home grown grain to town where the local mill prepared a balanced dairy ration. In each case the mill delivered the ration in bulk back to the farm. This method required considerable time and labor on the part of the farmer. In addition, the farmer paid the mill for the service provided. For these two reasons, few of today's dairymen use this method.

Some dairymen have a mobile mill come to the farm on a regular schedule. This method works well when such a service is available and dependable. The hired unit supplied both the labor and the equipment for preparing the dairy ration. One disadvantage with this system was that the dairyman was usually obligated to buy protein needs and other supplies from the custom operator. On farms where labor is at a premium such a system may be desirable.

A number of farmers have purchased their own mobile grinder-mixer mills which are powered by the farm tractor. With these mills two or more grains from different storage places on the farm can be collected and prepared into a balanced ration. The mill is then moved and the feed unloaded where it will be used. When adequate labor is

available on the farm owning a P.T.O. mobile mill will meet the needs of some dairymen.

A recent trend in grain feeding for dairy cattle has been the use of high moisture corn (28-32 percent) either as shelled or ground ear corn. High moisture ear corn is always ground by one of several available means before storing in a silo, whereas shelled corn is often rolled when brought out of the silo to be fed.

High moisture ground ear corn was used on two farms. On one farm it was fed in the silage bunk while the other operator fed it in the parlor. High moisture ground ear corn is an excellent feed but it does contain excess moisture and because of the cob a fair amount of fibre. For these two reasons alone this feed should be fed in bunk because cows are not in the parlor long enough to get their required energy from this ration. Also, there are fewer problems in handling ground ear corn when fed in silage bunk.

High moisture shelled corn was used on four farms and in each case it was rolled when removed from the silo. This is a daily operation because this grain will begin to spoil if left more than 24 hours after removal from silo. With proper equipment this is a small chore with respect to time.

One operator feeding 1200 pounds of corn to a 60-cow herd spent 12 minutes per day rolling corn and filling the feeders. Since it requires 5 minutes to fill the feeders,

the rolling operation only took 7 minutes per day. This amounts to some 43 hours for the year. Whereas another dairyman feeding a comparable amount of grain to a herd of equal size spent 3 man hours per week with a P.T.O. mobile mill grinding and mixing feed. This adds to 156 hours per year which is more than 3.5 times as long as the other dairyman.

Observations made during this study would indicate that high moisture corn is a convenient and efficient way of providing grain for the milking herd. High moisture shelled corn can be fed satisfactorily in either the parlor or silage bunk but high moisture ground ear corn should only be fed in the silage bunk. There appears to be considerable saving in labor by feeding grain in this form. Although this study was concerned only with labor requirements, high moisture corn offers other worthwhile conveniences to the dairyman.

Table 20 summarizes the time in minutes per cow per year spent for the different chores on all 16 farms. The end result includes all time in hours per cow per year required to care for the milking herd with the exception of preparing the grain ration. Since not all farms prepared their own grain ration, this chore was omitted so that all farms could be compared on an equal basis. The labor requirements ranged from 27.9 to 55.1 hours per cow per year. The results are in line with the labor requirements found on

Table 20. Total chore time for the milking herd

Farm	Collect Cows into Holding Pen	Prepare Milking Equipment	Milking	Clean Milking Equipment and Milk House	Clean Parlor	Wash Bulk Tank	Milking Time Hours/Cow/Year	Feed Hay	Silage Feeding		Prepare Grain Ration	Remove Droppings	Bedding	Scrape Min/Stall/Day	Load & Haul Min/Stall/Day	Manure Handling Time Min/Stall/Year	Cleaning and Feeding Time Hours/Cow/Year	Total Chore Time Hours/Cow/Year
									Machine Time	Operator Time								
1	131.4	81.0	1,503.8	173.0	278.1	131.4	38.3	116.8	259.2	129.6	....	32.8	54.0	.44	.38	299.3	10.5	48.8
2	130.2	114.5	1,510.3	139.8	136.5	50.5	34.7	89.8	208.1	187.3	144.0	32.8	77.2	.44	.49	399.5	12.0	46.7
3	243.3	100.6	1,825.0	187.7	174.1	....	42.2	....	375.9	150.4	....	32.8	37.2	.50	.52	372.3	9.9	52.1
4	113.2	65.2	1,990.9	163.2	123.6	46.9	41.7	....	394.2	236.5	62.6	32.8	32.4	.87	.51	503.7	13.4	55.1
5	56.0	72.1	1,152.6	67.6	78.0	....	23.8	31.9	273.8	136.9	68.4	32.8	54.0	.41	.79	438.0	11.6	35.4
6	88.8	50.4	1,251.4	90.9	204.7	59.7	29.3	16.6	146.0	146.0	39.8	32.8	20.4	.33	.37	255.5	7.9	37.1
7	76.7	96.2	1,752.0	138.1	120.6	....	35.6	25.4	153.3	38.3	16.3	32.8	20.4	.52	.46	357.7	7.9	43.6
8	46.2	33.5	1,018.6	75.7	45.6	....	20.3	30.4	98.6	29.6	....	32.8	9.0	.46	.50	350.5	7.5	27.9
Total	885.8	613.5	12,004.6	1,036.0	1,161.2	288.5	265.9	310.9	....	1,054.6	....	....	299.4	...	...	2,916.4	....	346.6
Mean	110.7	76.7	1,500.6	129.5	145.2	36.1	33.2	51.8	....	131.8	....	....	37.4	...	...	364.5	....	43.3
A	60.3	81.0	1,368.7	254.0	152.6	65.7	33.1	182.5	292.0	233.6	....	32.8	57.6	.64	.67	478.2	16.4	49.5
B	28.0	85.2	1,327.3	172.2	111.9	54.7	29.7	....	288.4	216.3	....	32.8	49.2	.72	.43	419.8	12.0	41.6
C	63.3	91.3	1,183.9	127.1	56.6	54.7	26.3	....	503.7	251.8	67.4	32.8	55.2	.26	.29	200.7	9.0	35.3
D	34.1	87.6	1,327.3	128.6	117.9	50.5	29.1	252.7	197.1	197.1	....	32.8	60.0	.32	.32	233.6	12.9	42.0
E	54.8	53.7	1,183.8	119.0	69.4	46.9	25.5	130.4	259.2	233.3	....	32.8	37.2	.45	.28	266.5	11.7	37.1
F	34.1	45.2	1,123.1	158.3	182.5	41.1	26.4	91.3	182.5	136.9	....	32.8	72.0	.60	.43	375.9	11.8	38.2
G	79.1	51.9	1,288.2	92.6	89.1	69.2	27.8	96.1	127.8	121.4	....	32.8	91.2	.68	.80	540.2	14.7	42.5
H	40.2	78.7	1,288.2	102.8	105.1	....	26.9	....	135.1	135.1	....	32.8	62.4	.26	.23	178.9	6.8	33.7
Total	396.9	574.6	10,090.5	1,154.6	885.1	385.8	224.8	753.0	....	1,525.5	....	....	484.8	...	...	2,693.8	....	320.1
Mean	49.6	71.8	1,261.3	144.3	110.6	48.2	28.1	150.6	....	190.7	....	....	60.6	...	...	337.7	....	40.0

Note: All columns expressed as min./cow/year unless otherwise stated.

MacLachlan, D.L., 1967, A Study of Dairy Chore Labor under Different Systems of Free-Stall Housing, M.S. Thesis, Michigan State Univ.

New York State farms which used free stalls, herringbone parlors and high silage feeding.

From a labor point of view milking is the most important of all the chores connected with the care of the dairy cow because it accounted for 55 percent of the total chore time. This indicates the importance of installing and operating an efficient milking parlor.

Manure handling accounted for 15 percent of the total chore time while feeding silage accounted for 7 percent.

Table 21 indicates inside feeding was slightly more efficient with a saving in excess of 3 hours per cow when compared without regard to manure handling.

There was no difference in manure handling when compared without regard to the type of housing.

Table 21. Labor requirements in man hours per cow per year for the four different housing systems

	Outside Feeding	Inside Feeding	
Conventional Manure	40.5	43.4	41.6
Liquid Manure	48.1	38.0	41.8
	43.3	40.0	

Liquid manure with outside feeding was the least efficient of the four housing systems. During the winter months the liquid manure system was only used 20 percent of the time which meant the manure had to be removed by some conventional means. This other method was usually poorly designed for labor efficiency since it was not a planned part of the system. The snowfall for the winter 1966-67 was considerably more than normal for Michigan. Therefore, on an average winter dairymen with a liquid manure system outside would likely to be able to use it more than 20 percent of the time. Also during periods of heavy rainfall often much water had to be pumped and hauled from these outside liquid manure pits. Hot dry weather in summer makes manure on outside yards too dry to work well in a liquid manure system.

Liquid manure increased efficiency of inside feeding because when cows were confined under cover the manure is usually quite sloppy. Such manure was very difficult to load with a bucket, stable cleaner or any other conventional manure handling method. Here the pit was installed under the barn making it convenient for scraping. This reduced scraping time. Snow, frozen manure, dry manure and excess water which were problems for outside liquid manure were not when this system was used inside.

To achieve maximum labor efficiency in covered housing liquid manure should be given consideration as a component part. Hay feeding should be excluded because of its inefficiency in this type of housing.

Outside feeding allows the use of hay without serious losses in efficiency. Conventional manure handling is to be preferred in as much as liquid manure in this system resulted in the least efficient system.

SUMMARY

A chore labor study for the milking herd was conducted from August 1966 through February 1967 on 16 Michigan dairy farms. All farms selected had relatively new dairy units using free-stalls, parlor milking and a high silage feeding program. Eight of the selected farms fed silage out in the yard and were considered open lot operations while the other eight fed silage in the barn were covered systems. A liquid manure system was used on eight farms, three of which were in the outside feeding group and five in the inside feeding group.

One day a month was spent on each farm observing, timing and recording the amount of time required to perform the different chores connected with caring for the milking herd. The data collected was summarized to give a mean time for each chore operation on the different farms. Finally a total chore time for each farm was computed in man hours per cow per year and then averaged for the different types of housing.

To collect cows into the holding pen it took 2.25 times as long for open-lot housing as it did for covered housing systems. One reason for this increase in time is that with open-lot housing cows must be gathered from a

larger area. Also it seems dairymen using this system are more prone to have heifers and dry cows with the milking herd, and these had to be separated from the milk cows going into the holding pen.

Several types of milking parlors were included in the study and it was found that the double four herringbone had the greatest capacity in cows milked per man hour. The milking rates found in this study agreed with the findings of other researchers. The importance of installing and operating an efficient milking system can not be over emphasized since milking accounts for 55 percent of the total chore time required for a cow.

The time in preparing milking equipment, washing milking equipment and milk house, and washing the parlor, although each relatively small in itself, did add up to a considerable amount of time. Here times varied widely between dairymen using the same system and the amount of time required may be closely related to the standard of cleanliness set by the dairyman. In general terms, five to six man-hours per cow per year are required for performing these three chores. Washing the bulk tank is another chore which fits into this group. Some bulk tanks were equipped with automatic washers which eliminated this chore entirely. Tank capacity nor washing frequency, whether daily or every other day, had little effect on the time required for each

washing. Approximately 20 minutes were usually required to wash a bulk tank.

Hay was fed only on eleven of the sixteen farms and even here it supplied only a small percentage of the total forage fed. Barns with inside silage feeding systems had no facilities for storing hay and thus all hay fed had to be hauled from some other barn. Such a procedure has high labor requirements as compared to the open-lot system which usually had proper facilities for storing and feeding hay. Dairymen with covered housing systems spent about three times as long feeding hay as those with the open lot system.

Silage feeding which eliminates physical labor is a good method for providing forage to dairy cows. Labor requirements were greatly reduced on farms where other chores could be performed while the unloading and feeding equipment were running.

The time spent bedding the cows varied greatly from farm to farm. The labor required to perform this chore was more closely related to the standard of cow cleanliness and cow comfort set by the dairyman than by the type of housing. Sawdust makes excellent bedding and works well with liquid manure handling. The use of straw for bedding should not be underestimated for free-stall housing. Straw was used with excellent results on some of the farms. When straw was used for bedding the stalls appeared comfortable, dry and were

readily accepted by the cows. If liquid manure handling is used it is necessary that the straw be chopped.

Next to milking, manure handling was the chore which required the most time. Frequency of scraping varied from twice a day on some farms to every other day on other farms. Daily scraping appeared to be most satisfactory both from a labor and cleanliness standpoint. The results of this study indicate that liquid manure handling is more effective in saving labor under certain housing conditions than others. With cold-covered and warm-enclosed free-stall barns liquid manure worked well, reduced time required to dispose of manure and provided a convenience of handling over conventional manure handling. The installation of liquid manure for open-lot systems did not reduce labor requirements over conventional manure methods during the period of this study. During the winter months of December, January and February it was estimated that those farmers using liquid manure facilities in the open-lot housing had to use some other method of manure removal 80 percent of the time. However this may not be a normal pattern because of the severity of the 1966-67 winter. The farms in this group were located in Southern Michigan.

The study showed that the labor required for the milking herd in hours per cow per year were 43.3 for farms with outside feeding as against 40.0 for those with inside feeding. This is a difference of some 3.3 hours in favor of

inside feeding. When liquid and conventional manure handling were compared without regard to the type of housing there was no difference.

Inside feeding coupled with liquid manure handling had the lowest labor requirement of the four systems studied. This was 38.0 hours per cow per year with next lowest being outside feeding with conventional manure handling at 40.5. Inside feeding with conventional manure handling required 43.4 hours, and 48.1 hours were required when cows were housed in the open-lot system using liquid manure.

Inside feeding with liquid manure handling requires the least labor and coupled with other previously mentioned advantages makes this housing system very suitable for Michigan dairymen.

CONCLUSIONS

Free-stall housing, herringbone parlors and silage feeding is a desirable housing arrangement for dairy cows, because the labor requirements for the dairy herd are much reduced over other housing systems such as the stanchion barn. The results of this study would indicate that the double four herringbone parlor is best suited for one man milking while the double eight is most satisfactory when two people work in the pit. Bulk tanks with automatic washing equipment eliminate another chore from the dairyman's list and such equipment will become more common on dairy farms.

In addition to lower labor requirements, other benefits such as protection of cows from snow and cold rains make inside silage feeding either in cold-covered or warm-enclosed barns preferable to open lot free-stall housing. Cold-covered barns are adequate and satisfactory in Southern Michigan where cold winter temperatures and heavy snowfalls are less of a problem. In the northern part of the state, however, there is a greater need and reason for constructing warm-enclosed barns.

Since these housing systems are not ordinarily designed for feeding hay it should be eliminated from the ration and the cows fed all silage which could be a combination of corn silage and haylage. It is expected that silage

feeding systems of tomorrow will have a greater degree of automation to allow the operator to perform other chores while the cows are being fed.

The confinement of milk cows on a year round basis leads to increased work and problems in disposing of the manure. When the confinement system involves covered housing with inside feeding, liquid manure answers the problem best since it reduces the labor required as well as providing added conveniences. The advantages of liquid manure handling are greatly reduced for open-lot housing. If a conventional manure handling method is used one of the better ways is to install a ramp whereby the manure can be pushed over the edge into a spreader. When conventional manure handling is used, this arrangement is superior to using a gutter cleaner or loading with a tractor bucket.

Free-stalls have greatly reduced the chore of bedding diary cows. However, this chore is still with us, and one that all dairymen wish to reduce further or eliminate entirely. Rubber or some synthetic material may be used in the form of mats to replace bedding in the future.

This study did not investigate thoroughly the problem of preparing and feeding grain to the dairy herd. But from limited observations and data the use of high moisture shelled corn provided a good quality feed with a minimum of labor. The trend to more of this type of grain feeding program is likely to continue.

The previous paragraphs outline the technology and management techniques which today's progressive dairymen are using. Other dairymen, to stay competitive will need to adopt and improve many of the principals outlined.

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APPENDICES

APPENDIX A

DAIRY CHORE SHEET

Name John Doe Address Lansing

Date 12-15-66 Choretimes: A.M. 5:30 P.M. 4:15

Dairy Chores	Men	Min.	Men	Min.	Men	Min.
Putting cows in holding pen	1	3.0	1	5.0		
Preparing milking equipment	1	8.0	1	7.5		
Milking and feeding grain	1	12.0	1	10.5		
Clean milking equipment & M.H.	1	9.0	1	9.0		
Cleaning parlor	1	8.0	1	6.5		
Feeding silage	1	2.4	1	2.2	1	10.0
Feeding hay	1	2.5	1	3.0		
Feeding green chop	None					
No. of cows	Thru 74	Milk 71	Thru 74	Milk 71		

Other Chores	Men	Min.	Frequency	Comments
Clean Free-Stall Barn	xxxxxxxxxxxxxxxxxxxxxxxxxxxxx			
Remove droppings	1	8.0	twice a day	
Hand scraping	1	6.5	daily	holding pen
Tractor scraping	1	2.8	daily	free-stall alley
Level bedding				
Setting up - agitating				
New bedding				
Load or pump manure	1	6.0	per	load
Haul manure	1	15	ave. hauling dis.	
Clean Outside Yard	xxxxxxxxxxxxxxxxxxxxxxxxxxxx			
Tractor scraping	None			
Hand scraping	None			
Fill grain storage				
Fill grain feeders	1	5	daily	

Cows Entering Parlor: Ex_____ VG_____ G_____ F_____ P_____

APPENDIX B

LABOR REQUIRED FOR MANURE HANDLING

Name John Doe

Address 2138 William Road

Date	No. of Loads	Total Time (man hrs.)	Crop Spread On	Comments
11-5	12	3.0	alfalfa sod	snow & manure
11-9	5	2.5	alfalfa sod	long haul
11-11	4	2.0	pasture	
11-21	5	2.5	corn stubble	
11-22	10	2.5	corn stubble	
11-29	10	4.0	alfalfa sod	
12-2	4	1.5	alfalfa sod	short haul
12-5	5	2.0	pasture	
12-10	5	2.0	alfalfa sod	deep snow
12-12	5	1.5	corn stubble	
12-14	6	2.0	corn stubble	
12-23	10	2.0	alfalfa sod	

APPENDIX C

LABOR INVOLVED IN BEDDING

Name John Doe

Address William Road

Date	Type of Bedding (sawdust, straw, cornstalks)	Amount (bales, wagon boxes, truck loads, etc.)	Distance Hauled	Time Required (man hrs.)
11-21	sawdust	1 truck load	5 miles	1.5 hrs.
11-30	sawdust	1 truck load	5 miles	1.5 hrs.
12-1	sawdust	1 truck load	5 miles	1.5 hrs.
12-4	sawdust	wagon load	5 miles	2.0 hrs.
12-7	sawdust	1 truck load	5 miles	1.5 hrs.
12-12	sawdust	wagon load	5 miles	2.0 hrs.
2-20	sawdust	1 truck load	5 miles	1.5 hrs.
2-20	sawdust	wagon load	5 miles	1.5 hrs.
2-22	sawdust	1 truck load	5 miles	2.0 hrs.
2-22	sawdust	wagon load	5 miles	2.0 hrs.

APPENDIX D

MILK SALES RECORD

Name of Producer John Doe

Month: Dates	Aug. lbs./ milk sold	Sept. lbs./ milk sold	Oct. lbs./ milk sold	Nov. lbs./ milk sold	Dec. lbs./ milk sold	Jan. lbs./ milk sold	Feb. lbs./ milk sold
1		8080	7817		9237		
2	6056			6800	8625		8492
3		7590	7563		8922		
4	6223			7095	8025		8414
5		7536	7831			9102	
6	6425			7021	8075		8441
7		7493	7654			8997	
8	6677			6714	8625		8499
9		7665	7922			7740	
10	6591			6954	8775		8506
11		7719	7713			8610	
12	6616			6854	8511		8623
13		7606	7396			8853	
14	7034			7034	8431		8321
15		7759	7294			8765	
16	6849			7089	8600		8271
17		7759	7391			9124	
18	6905			6911	8590		8346
19		7759	7027			8753	
20	7027			7273	8507		8800
21		7798	6772			8987	
22	7132			6948	8908		4198
23		7998	6972			8709	
24	7262			7764	8955		8357
25		8324	6438			9015	
26	7493			7798	9164		8410
27		7855	6719			8987	
28	7611			8092	9159		8655
29		7676	7052			8951	
30	7364			8310	8858		8552
31			6905			8586	
No of Cows Milking	111	101	87	108	124	115	116

APPENDIX E

Table 22. Silo capacity

Farm	Silo I	Silo II	Silo III	Silo IV	Storage Capacity
1	16x50 (c.s.)	20x60 (c.s.)	...	...	735
2	18x50 (c.s.)	18x50 (c.s.)	12x36 (c.s.)	12x36 (c.s.)	830
3	20x60 (H)	20x60 (c.s.)	20x60 (c.s.)	...	1449
4	20x50 (H)	20x50 (H)	20x50 (H)	...	1182
5	20x50 (c.s.)	20x70 (c.s.)	...	...	968
6	24x45 (c.s.)	24x45 (c.s.)	...	...	1012
7	20x60 (H)	20x60 (H)	...	...	966
8	26x60 (c.s.)	20x60 (c.s.)	...	...	1301
A	20x66 (con.)	12x44 (con.)	10x40 (con.)	...	725T
B	20x60 (H)	20x60 (H)	...	...	966T
C	20x60 (H)	20x50 (H)	...	...	877T
D	16x50 (tile)	20x50 (H)	...	...	646T
E	20x60 (c.s.)	20x60 (H) (being built)	...	...	966T
F	24x60 (c.s.)	20x60 (H)	...	...	1180T
G	20x60 (c.s.)	16x60 (c.s.)	...	...	788T
H	20x60 (H)	20x60 (H)	20x60 (H)	...	1449T

*Capacities calculated in terms of tons of corn silage, at 68 percent moisture; con. = poured concrete, c.s. = cement stave, and H = glass-lined Harvestone.

APPENDIX F

Table 23. Grain handling procedures

Farm	Type of Grain and Where Fed: Parlor	Type of Grain and Where Fed: Silage Bunk	Method of Preparing Grain
1	Dairy ration	None	Mobile mill comes to farm
2	Dairy ration	None	P.T.O. mobile mill to prepare their own feed
3	Dairy ration	None	Mobile mill comes to farm
4	H.M. shelled corn	None	Rolls corn each day from silo
5	Dairy ration	None	P.T.O. mobile mill; prepare own feed
6	H.M. ground ear corn	None	Ear corn ground when storing
7	Dairy ration	None	P.T.O. mobile mill; prepare own feed
8	Dairy ration	Ground ear corn	P.T.O. mobile mill grind own ear corn; dairy ration delivered to farm
A	Dairy ration	Dairy ration	Hauls grain to town mill. Prepared feed delivered back in bulk
B	Dairy ration	None	Mobile mill comes to farm
C	H.M. shelled corn	None	Rolls corn each day from silo
D	Dairy ration	Dairy ration	Hauls grain to town mill. Delivered back to farm in bulk
E	Mineral protein block	H.M. shelled corn	Rolls corn each day from silo
F	Dairy ration	None	Delivered in bulk to farm
G	Dairy ration	H.M. ground ear corn	Dairy ration purchased; ear corn ground when storing
H	H.M. shelled corn	H.M. shelled corn	Rolls corn from silo each day