# DESIGN OF LOW COST DAIRY STRUCTURES FOR HIGH LABOR EFFICIENCY

by

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# INTRODUCTION

## Two Types of Housing Systems: Stanchion Barn and Parlor-Loose Run

Stanchion Barn. The stanchion barn method has been used for many years and can be considered the standard method of housing dairy cattle. This method hinges around the stanchion barn in which the cows are stabled, each cow in her own stall. The cows are milked in these stalls the year round and, in more northerly climates, may be kept in their stalls continuously during the winter months except for brief periods daily when the cows are turned out for exercise and perhaps water. Cows are allowed to graze on pasture when pasture is available. Hay and silage are usually fed in the manger of the stanchion barn, though some dairymen feed outside. Hay is usually stored in a loft over the cows, and the silo is usually attached to or placed very close to the barn. Concentrates are usually stored in a bin in the barn or between barn and silo. The milkhouse formerly was required to be some distance from the barn, but more recently it has been placed on one side or end of the barn and connected to the barn by a ventilated, double-doored passage. This method is quite compact and rather impressive to observe, but the buildings are also very expensive to build.

Parlor-Loose Run. This method is built around two main features. One is the small milking barn, often called a milking parlor. This building has only a few stalls and usually contains

a concentrate room and milkhouse all under the same roof. The other main feature of the loose housing method is the pen, or loose run, barn in which the entire milking herd is sheltered without being separated. Sometimes dairymen have two or three groups of cows separated for such considerations as disease, feeding age, and "boss cows". However, the pen barn for all groups is usually a single building. Many combinations of hay storage, silage storage, herd shelter, calf barn, and milking barn qualify for the classification of loose housing including those which provide no shelter except for milking.

## Much Labor Involved in Dairying

This manuscript is primarily concerned with the study of labor involved in dairying and how to reduce it by better work methods, by better building arrangements, and by the use of equipment to replace man labor where economical. Dairying and drudgery have been considered synonymous for a long time. Most dairy herds are less than 30 cows. This means that a large force of men cannot be employed to do the dairy work because of high labor cost. Some dairys of 20 - 30 cow size are operated by one man; others are operated by two, three, even four persons. Many dairymen have abandoned dairying in favor of other farm enterprises because their system required more men at milking time than could be profitably employed full time. Other prospective dairymen have failed to undertake the profession for the same reason. A requirement that appears imperative for the average

size dairy of up to 40 cows is that one man be able to do all the dairy chores each day. If more than the one man are available, there are always numerous other chores besides the milking that can be done while the one man is milking and doing the dairy work. Thus, if at some future time there is only one man available, the dairy enterprise will not be crippled.

## Purpose of Investigation

Development of a Comparison Method. The first objective was to develop a method of comparing various arrangements, sets of equipment, and work methods without actually operating a group of barns with the same crew to make comparisons. It was felt that a method of comparison would be very useful if it could be applied quickly and would eliminate herd and operator variations that always result when an actual trial is attempted. The actual trials, too, are very expensive and time consuming.

Comparison of Existing and Proposed Arrangements. The second objective was to compare several well known parlor arrangements with each other and with a standard stanchion barn all from the standpoint of labor required. Also, it was intended to compare the labor requirements of alternate pieces of equipment as well as work methods for a few jobs.

# REVIEW AND INTERPRETATION OF LITERATURE

## Importance of Labor in Dairying

Proportion of Labor that is Dairy Chores. The enormous

amount of labor associated with dairying is realized by everyone qualitatively but not quantitatively. Bookhout (2, p. 15) states that chore work on dairy farms makes up more than half of the entire yearly work. He also reports that on 10 selected Michigan dairy farms in 1946, the dairy cows themselves required an average of 5 hours and 9 minutes or 86 percent of the total chore time during the winter. Since chores constitute most of the winter work, nearly 86 percent of the dairyman's working time was spent on the milking herd. In addition, 5 percent of the dairyman's time was spent on the bull and young stock affiliated with the dairy herd. This makes a total of 91 percent of the dairyman's winter work time spent on the herd. Murphy (13, p. 6) reports that, on 12 specialized dairy farms in New York (1943), 54 percent of the total yearly labor was spent on the dairy enterprise. Certainly, there is an opportunity to make some substantial monetary gains by reducing this labor requirement.

Cost of Labor on Dairy Farms. The only annual cost in keeping a dairy herd that exceeds the labor cost is feed cost (7, p. 5). This situation is well recognized by anyone familiar with the routine a dairyman follows each day. Murphy (13, p. 5) indicates that a great deal of interest on the part of dairymen has been aroused on the subject of dairy labor because of the high proportion of labor in the total cost of dairying. It appears then, that a substantial reduction of labor required would be a very worthwhile accomplishment.

Proportion of Dairy Chore Time on Each Job. In order that any important amount of time can be saved, it is necessary to have some idea of the time distribution of dairy chores by jobs. Very little can be gained on a job that requires only 8 or 10 minutes each day. On the 10 Michigan farms mentioned above, 48 percent of the dairy chores was spent milking, 16 percent feeding, 13 percent caring for utensils, 13 percent cleaning stables and bedding cows, 6 percent handling milk, and 4 percent getting cows into and out of the barn (2, p. 16). The total time per cow averaged 17.1 minutes per cow per day. Murphy (13, p. 11) found for the 22 New York dairy farms that 51 percent of the dairy chore time was spent milking and milk handling, 19 percent cleaning stables and bedding, 13 percent feeding, 9 percent caring for bull and young stock, and 8 percent for all other. The total time per cow averaged 21.42 minutes per day. The above 2 studies were made in the winter and, while the jobs were grouped slightly differently, the distribution is quite similar. Smith (19, p. 75) studied 15 herds in Maryland during the summer months and found that 68.7 percent of the dairy chore time was spent milking, 12.7 percent cleaning barns, 11.6 doing milkhouse work, 3.6 percent feeding grain, and 3.3 percent feeding silage. The total time per cow averaged 9.73 minutes per day. It is apparent that much less time for feeding, cleaning, and bedding was required during the summer. The above chore time distributions were for stanchion barn systems. Less cleaning time was the most outstanding difference for loose housing systems.

In the 4-year summary of stanchion vs. loose housing system research at the University of Wisconsin, it is shown that the loosely housed herd required a yearly total of 84.65 percent of the labor of an equal size, stanchion housed herd for the case of cleaning the pen barn mechanically (6, p. 3). Part of this saving was on milking and part was on cleaning and bedding. From the above figures, it can readily be seen that the jobs that offer the most opportunity for time savings are milking, feeding, cleaning, and bedding.

## Practices Recommended in Dairying

Proper Methods of Milking. Though the rules for excellent milking practices have been well set forth, many dairymen lose much milk as well as time by leaving the milker on the cow too long and by hand stripping too long. Petersen (15) gives the four rules of good milking: (a) stimulate cow by washing udder and foremilking 1 minute prior to attaching milker; (b) operate milker according to manufacturer's instructions; (c) do not let teat cups crawl up on udder; and (d) strip by machine and take machine off when milk flow ceases. He also states that, with a few exceptions, each cow will milk out in 3 1/2 minutes or less. Petersen describes (16, p. 14-15) the milk secretion process as a continuous storage of milk between milkings in small cells (alveoli) of the udder. When the milk pressure in these cells reaches 1/4 to 1/3 (30 - 40 mm of Hg.) blood pressure, secretion stops. The rate of secretion is

somewhat inversely proportional to this pressure. These cells are emptied by hormonal activity that is brought about by one or more stimuli such as udder washing, foremilking, feeding, or a calf nursing. This hormonal activity resulting in the "let down" of milk requires about 40 seconds from the time of the stimulus to the time of complete "let down". This hormone activity lasts only a short time, so the milking operation must be initiated and completed during the time of high activity or incomplete milking will result (a 1 cc dose of standard oxytocin injected intraveneously was effective in stimulating milk flow for only 10 minutes). Incomplete milking, of course, results in the udder pressure remaining high with a consequent reduction of secretion between milkings. Continued incomplete milking will result in the cow drying up sooner than she would under proper milking practices. Turner (20, p. 12) found the time between stimulus and "let down" to be from 1/4 to 2 minutes. He also found that some cows respond only to feeding instead of responding to udder washing and foremilking. It would appear, in view of the above findings, that a consistent routine is a necessity in milking so that the same thing each milking will stimulate the cow and so that the particular stimulus will occur at the proper time prior to attaching the milker. Parlors appear especially good from this standpoint in that the cow is brought into contact with the various stimuli only shortly before she is milked. Training the cows to respond to udder washing and foremilking is the best procedure, as these

operations can be timed more accurately with respect to milking than can be feeding.

One problem that every dairyman has is the few cows that will not milk out rapidly regardless of stimulation or proper milker handling. These cows should be milked last to avoid interrupting the routine or disposed of if they are not too valuable. The reasons most cows are using more time to milk than necessary are given by Murphy (13, p. 16, 17) as (a) cows not trained properly, and (b) failure of the operator to remove milker at proper time. This agrees with Mr. Petersen's recommendations as given above for proper milking methods. Smith (19, p. 90) believes that machine stripping is sufficient and that hand stripping should be entirely discontinued.

Feeding Practices Recommended. Feeding grain during milking is a very convenient and recommended practice (7, p. 46) for parlors. It is usually fed just prior to milking in stanchion barns. For parlors, the grain ration helps attract the cows to come into the milking stall by herself. Some milk ordnances, however, are objecting to feeding grain in the milking barn, though tests indicate very clean milk can be produced in parlors where grain is fed during milking. Hay feeding should be fed under cover to avoid weather damage (7, p. 32). Hay, when fed in a rack alongside the storage, should thus be covered by at least a short roof over the hay. Manger standing space per cow should be about 2 1/2 feet (1, p. 215).

Silage may be fed out in the open if fed daily so as to keep

fresh (7, p. 32).

Bedding the Cows. Approximately 60 square feet of bedded area per cow is required for pen barns (7, p. 39). A manure pack of as much as 3 to 3 1/2 feet should be allowed to accumulate in the loafing barn to provide the cows with a warm bed and to reduce cleaning time for the herd (24, p. 25). Also, the bedded area should not be used for traffic lanes, feed mangers, or water tanks. Bedded areas can be relieved of their burden somewhat by providing a well drained lot with windbreak to keep the cows off the bedding as much as possible. The loafing shed should be operated with a south door open to reduce moisture problems and to prevent bedding from becoming moist too rapidly.

Care of Milk. Milk must, of course, be handled in sanitary containers at all times. In addition to this requirement, milk must be cooled quickly after it is drawn (18, p. 5). Cold air has been found nearly worthless for cooling milk by placing milk cans in a refrigerated box (18, p. 38). However, the use of a surface cooler makes possible the use of dry cold air storage since the surface cooler can cool the milk almost immediately to the temperature desired (12, p. 15). When the milk is picked up from the farm before a tank cooler has time to cool the milk, a surface cooler is especially necessary (10, p. 12). This situation exists or can exist for a large proportion of dairymen.

Care of Utensils. In order to produce clean, low-bacteria

milk, the utensils (such as milker, strainers, surface cooler, cans, pumps, milk pipe, and any other equipment contacting the milk) must be maintained in a sanitary condition. This is normally done as described by Wilster and Ewalt by rinsing, washing, rinsing again, and sterilizing. This is not a long job on any piece of equipment except the milker which requires disassembly and reassembly in the process. Elder (9, p. 106) and Pendleton (14, p. 148) both report very successful results of washing milkers by the so-called "flush" method whereby the machine is washed without disassembly. This process consists of, (a) sucking warm (130° - 150° F.) water with wetting agent (such as Dreft, Vel, or Swerl) into machine, lifting teat cups out of water several times during filling. Shake milker vigorously. Dump this water. (b) Draw very hot (165° - 175° F.) water through milker, shake, and dump. Hang milker up to dry. (c) Before next milking rinse milker with chlorine water. This process requires about 4 minutes per single milker. Pendleton found a cold water pre-rinse unnecessary and also that milkstone deposits were built up slowly enough that only very occasional brush washing was necessary.

## Shelter Needed by Dairy Cattle

Stanchion Barn vs. Loose Housing. Approximately 50° - 60° F. seems to be the optimum temperature for dairy cows. This temperature, of course, cannot economically be maintained constantly because of pasture utilization in the summer. However,

stanchion barn owners usually try to operate their barns in this range during the winter. A mistaken belief that dairy cows must be housed at these warm temperatures has resulted from the above practice. Witzel (24, p. 20) found that in stanchion barns the production increased as the barn temperature was raised from 40° to 60° F. However, in the loose run barn operated with a south door open at all times, the production was unaffected by temperature fluctuations. Witzel also reports no appreciable difference in yearly milk production for otherwise equal herds housed in the two manners. These tests were made in Wisconsin where the winters are relatively severe. In view of the above findings, it appears that the loose housing plan has no objections from the standpoint of production.

Cow Health Good in Loose Housing. One of the most marked advantages the Wisconsin studies have shown is that cow health is better and that injuries are much fewer (6, p. 5).

Disadvantages of Loose Housing Method. Witzel (24, p. 23) sums up the chief disadvantages of the loose housing system as:

(a) Requires more bedding--disadvantageous where bedding is scarce.

(b) Boss cows may be troublesome, especially if manger space is limited.

(c) Dehorning is necessary.

(d) Cows may show off poorly.

(e) Requires careful planning. More space needed.

(f) Milking parlors require other heat than that from the cows.

(g) System is new to many operators and hired help.

In a production herd, as contrasted to a breeding herd, the only disadvantages listed above that are serious are (a), (b), and possibly (g). Heat can be supplied artificially at a rather low cost in the parlor for the few hours a day that it is needed. Most dairymen can soon learn to operate the loose housing system well.

## Methods of Time and Motion Study

Methods Other Workers Used. Wilkins (21, p. 5-9) studied work routines and time required in a laboratory barn where the same herd and operators were used on various types of parlors. These parlors were constituted by making the stalls in units and shifting them to various positions. Murphy (13, p. 7) and Carter (4, p. 3) made their studies on existing herds. In all three cases, similar methods were used. First, the routine was studied and scale drawings made of the buildings to be studied. Then, during the milking or feeding the data taker recorded work element done, time each work element was completed and points of travel. The time for each work element was thus obtained by subtraction. Distances were obtained either by observation of pre-measured routes or by measuring later between recorded points on the scale drawing. No attempt was made to break the work elements drawn into therbligs. Much gain may be obtainable by a complete study of each oft-repeated work element to learn the most efficient exact routine to use.

Leveling for Skill and Effort. When time and motion studies are used in factories or offices for the purposes of determining pay rates, some recognition must be given to the degree of skill and effort displayed by the worker that was chosen to be studied. If he is particularly adept and works hard, apparent rates expectable would be at variance with those obtained if the subject were poorly skilled and did not put forth much effort unless a leveling process were used to arrive at the same "normal" rates of doing work regardless of which man were used for the study (11, p. 23). In dairy work, however, the objective is not to set rates of pay for given jobs but to determine combinations of equipment, building arrangements, and work routines that require the least labor. Strictly speaking, leveling should be done in dairy work studies, but the jobs are so many and varied that it is impracticable to make estimates of the operator's skill and effort that mean anything. When arrangements are compared, only the ratio of time required on various work elements is necessary, so it appears that leveling (which is only estimating performance levels anyway) has no place in dairy labor studies.

Construction of Jobs from Work Elements. Lowry (11, p. 79) says that a job routine may be constructed from its component parts, whose times are known, to form the standard time for the job even though the job has not actually been performed and timed as done by the proposed routine. This method obviously gives the investigator an opportunity to try a lot of combinations of

work elements without actually doing the study for each combination.

## Performances of Men, Animals, and Machines

Machine Time. Machine time is that time which the milker is actually on the cow. Machine stripping time is included when stripping is done by machine. Following is a table of values for average machine time various investigators found for herds studied.

Table 1. Machine and stripping time from other investigators.

| No. cows times | Machine time (mins.) | Stripping time (mins.) | No. cows stripped | Wt. of milk (lbs.) | Investigator |
|---|---|---|---|---|---|
| 21 | 8.5 | 1.5 | 9 | 8.3 | Carter (4, p. 13-15) |
| 813 | 6.15 | 1.38 | 566 | - | Murphy (13, p. 14, 15) |
| 163 | 5.71 | 1.2 | - | - | Bookhout (2, p. 18, 19) |
| - | 6.50 | - | - | - | Williams (21, p. 7) |
| 308 | 5.10 | - | - | - | Mich. Ag. Expt. Sta. Rpt., 1949-50 (17, p. 5) |
| - | 5.9 | 1.15 | - | - | Zuroske (25, p. 17) |

Machine time is important in that dairymen have an opportunity to decrease the total milking time considerably provided they can

work the decreased time into their routine and get back to the milker just before the cow is finished (25, p. 17). As discussed earlier, it appears desirable to use a milking interval of from 3 to 4 minutes. Thus, it is seen that nearly all dairymen are using far too long a machine interval. Zuroske (25, p. 19) found that production and machine time were independent, machine time being more a matter of training than anything else. Carter (4, p. 14) was able to reduce machine time on a herd from 8.5 minutes to 4.4 minutes in a month and to 4.0 minutes in another month by using recommended fast milking methods. Dahlberg (8) found in 5 years study that production was maintained better when uniform machine time of 4 to 5 minutes was used. He also found only 1 cow in 8 or 10 that needed hand stripping.

Zuroske (25, p. 16) shows that man minutes per cow to milk goes down as the number of machine units per man increases, but that machine time seems not to be a function of units per man up to a certain limit. The dairyman must be able to get to the cow before she is dry to machine strip and remove the milker. Wilkins (21, p. 11) made trials in the laboratory milking barn at Wisconsin and found that machine time increased from 2 minutes and 52 seconds in a "U" tandem parlor when a man operated one bucket milker[1] in 2 stalls to 3 minutes and 39 seconds when

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[1]A bucket unit consisted of one machine head, a blank head, and two milker pails.

he operated two units in four stalls. This time is still well within the recommended 3 to 5 minutes and it might be questioned whether the 2 1/2 minute machine time could be maintained in most herds. Since the schedule when using 2 machines allowed time to get back to the cows in about 3 1/2 minutes, it would appear that 2 units could be used and still not exceed the recommended machine time for this type of parlor.

Cows Milked Per Man Hour. This is the real criterion of efficiency of milking. The recommended milking practice of 3 to 5 minute machine time must be attained, but any process that will make an increase in the cows milked per man hour will, of course, reduce the milking time for the herd. The extra time to care for an extra milker must be subtracted from the total time gained in milking the herd, however. Wilkins (21, p. 11) shows that cows milked per man hour in the case cited above increased from 17.3 to 25.6 by virtue of using a 4-stall "U" parlor instead of a 2-stall "U" parlor even though the machine time increased for the 4-stall trial as also noted above. Carter (5, p. 13) believes that one man can do the dairy work much more efficiently in terms of man minutes per job than more than one man. This suggests the soundness of the proposal to use one man for doing the dairy work (or at least the milking) and using any other available help on other chores.

Time Needed for Cows to Eat Grain. Byers (3, p. 11) found that cows had from 10 to 15 minutes to eat grain in a 4-stall walk-through parlor when 2 units were used. He neglected to

state, however, the machine time associated with this eating time. Wilkins (21, p. 13) found cows requiring about 1 minute per pound of grain eaten plus 1 minute. In other words, a cow receiving 5 pounds of feed would require 6 minutes to eat. No effort was made to speed up eating time, though this feasibly could be done if the cows were trained to eat rapidly. Time needed to eat their grain is important in that there must be a sufficient number of milking stalls provided in a parlor to allow the cows to eat the grain ration necessary at the time of year when grain feeding is heaviest.

Necessity of a Gutter in Parlors. Gutters are, of course, necessary in stanchion barns where the animals are in their stalls nearly all day. Many plans for parlors show gutters, but many owners question their necessity since the cows are in the stall for such a short period. Wilkins (21, p. 13) observed only about 1 cow in 20 leaving droppings. He also found that some exercise in the lot such as a little driving tends to make the cows drop their excrement in the lot and thus reduce the number of piles in the parlor. At such a low frequency of droppings, gutters appear superfluous, especially in types of parlors where the operator must cross the gutter repeatedly. A gutter at best is dangerous to both operator and animals.

## METHODS AND EQUIPMENT USED

### Time Studies on Dairy Farms

Equipment Used. The principal equipment in the time studies

consisted of the dairy herd, buildings, feed, and equipment at the farm. Equipment used by the author and associates in making the investigation included stopwatches for accurately timing operations; spring balances for weighing grain, hay, milk, and silage; measuring tape for plotting farmstead and milking barn to scale; plane table and drawing instruments for making sketches; clipboards and forms for recording data.

Procedures Followed. In making the study, one observer usually watched the operator while the other timed the cows eating and milking.

1. Work Elements Timed Accurately. At first, an attempt was made to keep a time record of all operations by reading the stop watch at completion of each operation as the other investigators did. However, it was soon discovered that the timing error on many short operations was large in proportion to the actual time spent doing the work element. Since the comparison of barns was to be by building up the routine from job elements, it was very important to have accurately timed work elements. This was especially true of dairy chores since most of the work elements were of short duration. In other words, dairy work is a big job composed of a large number of oft-repeated small work elements that must be effectively incorporated into a smooth routine. Therefore, the observer who followed the operator started his watch when a work element started, stopped the watch at the completion of that element, and recorded on his data sheet the work done and time required. In following this procedure,

the dairyman usually did some work while the observer was recording, so the observer would just wait till another work element started. Care was exercised to avoid missing a large proportion of some particular work element.

2. Stall Schedules Recorded. In an effort to learn about the functioning of stalls, one observer timed all operations pertaining to several stalls. This procedure gave some information on such things as time cow is in stall before milker is attached, time in stall before udder washed, time in stall before fed, time in stall after milker removed and other relevant data.

3. Cows Timed for Eating and Milking. One of the most critical problems associated with small milking parlors is the one of allowing enough time for the cows to eat their concentrates. One observer, therefore, recorded the time each cow needed to eat a given amount of feed and also the machine time for each cow. This was done by recording start and finish time for each operation.

4. Drawings Made. The farmstead plan and a detailed plan of the milking barn, milkhouse, feedroom combination were drawn to scale at each farm. This made it possible to record the places of departure and arrival along with the time required and later get the distance by map measurer.

## Method of Analysis

Determination of Representative Performances. It should be

stressed that the objective of the investigation was to compare various buildings, arrangements, and work methods. Therefore, the time for doing each work element needed to be known within reasonable limits. Arbitrary time for work elements could have been assigned, but each plan requires different proportions of the work elements, which requires that the unit time for each element be known fairly accurately.

No attempt was made to use an equal number of entries for each work element from each dairyman because the routines varied so greatly that to have done so would have resulted in discarding a majority of the data. In other words, each measurement was equally weighted. Some inconsistency was, of course, encountered because of this such as one man making a large number of trips at, say, 50 feet and another at 40 feet. The man who made the 50 foot trips may nave been a fast walker, whereas the man who walked 40 feet may have been a much slower walker. This could make it appear that it takes less time to walk 50 feet than to walk 40 feet. It was considered, however, that a sufficient number of operators were observed (19 different dairymen; several of these more than once) that this sort of trouble was not important.

An important consideration on time studies of dairy work is that each time a given work element is performed, it will not be done in the same time by the operator. Time measurements for doing work are not like measuring a bolt with a micrometer where the variation is small compared to the true diameter.

Time for doing these work elements actually varies over a wide range and must be allowed for by such means as averages.

Following are the main classifications of performances that were determined and the method of analysis:

1. Operations requiring time only (no distance, pounds, gallons, etc., involved).

    a. Simple averages were used to arrive at representative time.

    b. Most milkhouse chores and many milking chores fall under this classification.

    c. Examples: Time to wash milker bowl; time to attach milker, time to disassemble milker head.

2. Walking.

    a. Cows. Cows were timed walking various distances and curves drawn to obtain probable time for any distance.

    b. Dairyman. Curves were drawn for time vs. distance for varying loads to obtain time for a man to walk a given distance and carrying a given load (see Appendix for method of arriving at these curves).

3. Machine time. Machine time was recorded and averaged. It was also plotted against amount of milk given.

4. Eating time. Obviously time to eat must be associated with the amount of grain eaten. The weighted average time for a cow to eat a pound of grain was calculated. A curve of time vs. amount eaten was also drawn.

5. Hay and silage feeding time. These operations were, of course, broken down into their elements. Part of these operations were walking in the mow and on the ground. This part was handled as described above. The other parts such as pitching silage,

cutting down a bench of hay, and obtaining loose hay were calculated on the basis of minutes per unit weight.

6. Barn cleaning time. Barn cleaning was classified by method used to clean. Within each method, the time required was computed on the basis of minutes per 100 square feet of floor area.

## Construction of a Good Work Routine and Comparison of Systems

Work Routine. For the purposes of comparing buildings, the best possible work routine was used. This routine may not have been used by dairymen observed who used a given type of barn, but to have a basis for comparison of buildings, the work routines must all be good ones. Routines that were developed were as follows:

1. Milking. This included attaching milker, detaching milker, carrying milk (except for combine milkers), dipping teat cups, moving milker from cow to cow, washing udders, machine stripping, foremilking, and dumping milk for all barns. For parlors, getting cows in and out and feeding them must be added to the above in the routine.

2. Milk House Chores. Included under milkhouse chores before milking: assemble milker, rinse milker and milk cans, prepare strainers, prepare teat cup rinse solution, and assemble milker (if done), wash and rinse milker, put cans of milk in cooler, disassemble strainers, wash and rinse parts and

strainers, wash rags used to wash cows' udders, wash and rinse surface cooler, and wash down milkhouse floor.

3. Feeding. Feeding includes: for silage - climbing into silo, pitching silage down into cart or trailer or pile on ground, climbing back down from silo, transporting silage from silo to bunk, and placing silage into feed bunk; for hay - climbing up to mow, cutting down loose hay, carrying hay to hay drop, climbing down from mow, transporting hay to manger where necessary, and placing hay in manger where necessary; for grain - obtaining basket or pails of grain in feed room, fill feed cart with grain, and fill storage boxes. Feeding the cow in her milking stall has been included in milking jobs.

## RESULTS OF TIME STUDIES

Since the original data as recorded were rather voluminous, only summarized figures will be given. In some cases, only the final results such as an average figure or a curve will be included.

### Time Requirements for Man Doing Work Elements of Dairy Chores

Milking.

Table 2. Time required for work elements of milking job that involve time only.

| Work element | Average time required (min.) | No. of observations |
|---|---|---|
| Open cow door (by rope) | 0.06 | 72 |

Table 2. (concl.).

| Work element | Average time required (min.) | No. of observations |
|---|---|---|
| Latch cow in stall | 0.04 | 50 |
| Feed cow grain | 0.234 | 61 |
| Wash udder | 0.223 | 100 |
| Attach surcingle | 0.013 | 30 |
| Attach milker (bucket) | 0.37 | 148 |
| Attach milker (combine) | 0.191 | 16 |
| Check milker | 0.27 | 22 |
| Machine strip | 1.24 | 7 |
| Hand strip (see table 1) | 1.35 | 997 |
| Detach milker (bucket) | 0.158 | 76 |
| Detach milker (combine) | 0.075 | 14 |
| Transfer head from one milker bucket to another | 0.08 | 8 |
| Dip teat cups in sterilizing solution | | |
| a. One solution | 0.0645 | 12 |
| b. Two solutions | 0.071 | 7 |
| Detach surcingle | 0.064 | 16 |
| Release cow from stall | 0.037 | 20 |
| Dump milk | 0.171 | 89 |

## Milk House Chores.

Table 3. Time required for work elements of milkhouse chores that involve time only.

| Work element | Average time required (min.) | No. of observations |
|---|---|---|
| Bucket Milker: | | |
| Assemble milker (complete) | 1.22 | 23 |
| Disassemble milker (complete) | 0.57 | 4 |
| Rinse entire milker without disassembly | 0.51 | 14 |
| Wash teat cups and inflations | 0.91 | 6 |
| Rinse teat cups and inflations | 0.014 | 8 |
| Wash milker bowl | 0.54 | 17 |
| Rinse milker bowl | 0.22 | 17 |
| Wash milker head | 0.33 | 5 |
| Rinse milker head | 0.22 | 7 |
| Combine Milker: | | |
| Assemble pipe line filter | 0.75 | 2 |
| Insert filter in line | 1.98 | 2 |
| Assemble can filler header group | 4.2 | 2 |
| Disassemble can filler header and filter group | 1.90 | 2 |
| Wash can filler header and filter groups | 1.00 | 2 |
| Rinse can filler header and filter group | 0.15 | 2 |
| Assemble milker unit | 0.635 | 8 |
| Disassemble milker unit | 0.43 | 8 |

Table 3. (cont.).

| Work element | Average time required (min.) | No. of observations |
|---|---|---|
| Wash rinse, and hand on disinfect rack one milker unit | 0.29 | 8 |
| Attach milker unit to pipe lines | 0.23 | 8 |
| Rinse milker | 0.90 | 9 |
| Detach can from fillers, dump water and replace can on filler | 0.41 | 9 |
| Detach can from filler and dump water | 0.31 | 9 |
| Disassemble can filler | 0.32 | 6 |
| Wash and rinse can filler | 1.00 | 6 |
| Assemble can filler | 0.52 | 6 |
| Strainers: | | |
| Assemble | 0.224 | 10 |
| Disassemble | 0.157 | 10 |
| Wash | 0.37 | 15 |
| Rinse | 0.20 | 12 |
| Pails: | | |
| Wash | 0.28 | 11 |
| Rinse | 0.21 | 13 |
| Water: | | |
| Prepare vat of wash water | 0.42 | 5 |
| Prepare jug of sterilizing solution | 0.52 | 8 |
| Fill pail with water | 0.40 | 14 |

Table 3. (cont.).

| Work element | Average time required (min.) | No. of observations |
|---|---|---|
| **Milk Cans:** | | |
| Remove can from can rack | 0.08 | 4 |
| Wash 10-gallon milk can | 0.77 | 4 |
| Rinse 10-gallon milk can | 0.26 | 7 |
| Lift can of milk into cooler | 0.24 | 35 |
| Hoist can of milk into cooler with pulley hoist | 0.68 | 4 |
| Hoist can of milk into cooler with vacuum hoist | 0.66 | 10 |
| Lift can of milk from cooler | 0.151 | 4 |
| Put lid on can of milk | 0.04 | 5 |
| **Strip Cup:** | | |
| Wash | 0.22 | 3 |
| Rinse | 0.07 | 8 |
| **Bottles:** | | |
| Bottle and cap milk with single units (per bottle) | 0.235 | 72 |
| Put case of bottles in dry cooler | 0.185 | 7 |
| **Milk House:** | | |
| Wash down milk house | 1.50 | 6 |
| **Surface Cooler:** | | |
| Wash surface cooler | 0.72 | 2 |
| Rinse surface cooler | 0.15 | 2 |

Table 3. (concl.).

| Work element | Average time required (min.) | No. of observations |
|---|---|---|
| Miscellaneous: | | |
| Wash udder rag | 0.075 | 20 |
| Disinfect udder rag | 0.02 | 20 |
| Attach teat cups to sterilizing rack | 0.21 | 3 |

Feeding Grain, Hay, and Silage.

Table 4. Time required for work elements of feeding grain.

| Work element | Minutes | Per | Minutes | Per |
|---|---|---|---|---|
| Fill pail (20#) with grain | 0.167 | pail | 0.0078 | pound |
| Fill feed cart (80#) with grain | 1.4 | cart | 0.0175 | pound |
| Fill bushel basket (50#) with grain | 0.25 | basket | 0.005 | pound |

Table 5. Time required for work elements of feeding hay.

| Work element | Minutes | Per | Minutes | Per |
|---|---|---|---|---|
| Pitch chopped hay (7.4#/fork) | 0.103 | fork | .014 | pound |
| Spread bales in manger (65#) | 0.78 | bale | .012 | pound |
| Break bales (65#) | 0.242 | bale | .00372 | pound |
| Pitch loose hay (8.2#/fork) | 0.11 | fork | .0135 | pound |
| Sweep mangers (stanchion barn) | 1.06 | sq. ft. | 0.109 | stall |

Table 5. (concl.).

| Work element | Minutes | Per | Minutes | Per |
|---|---|---|---|---|
| Throw bales from mow | 0.226 | bale | 0.00348 | pound |
| Cut down loose hay in mow | .0187 | pound | - | - |
| Climb into mow | .0197 | foot | - | - |

Note: When loose hay carried by fork, average load = 14.3#.

Table 6. Time required for work elements of feeding silage.

| Work element | Minutes | Per | Minutes | Per |
|---|---|---|---|---|
| Pitch silage (12#/fork) | .0975 | fork | .00815 | pound |
| Climb into silo | .0197 | foot | - | - |
| Distribute silage in bunk from cart with bottom doors and rolling on top of bunk | 4.0 | cart | .0066 | pound |

Table 7. Time required for work elements of miscellaneous feeding jobs.

| Work element | Minutes | Per |
|---|---|---|
| Hitch trailer to tractor | 0.61 | hitch |
| Move tractor and trailer from one position to another close by | 0.56 | move |
| Start tractor and get out of shed | 0.83 | start |
| Push cart loaded with silage hay or grain | 0.0045 | foot |
| Push empty cart | 0.004 | foot |
| Drive truck in lot for feeding | 0.0025 | foot |
| Pull trailer with tractor for feeding | 0.00297 | foot |

Table 7. (concl.).

| Work element | Minutes | Per |
|---|---|---|
| Place on or remove from cart a feed storage box | 0.12 | - |

Cleaning and Bedding. Milkhouse cleaning was included in the milkhouse chores. Cleaning and bedding here includes only the milking barn. During the summer, the barns can be cleaned by hosing and sweeping. This method was used in the comparisons for all barns for summer conditions. Hosing and sweeping can be used for parlors in the winter where heat is provided, but the stanchion barn cannot be hosed because the cows and bedding would become wet. Therefore, stanchion barns (and parlors if no heat is provided) must be cleaned in the winter period by scraping, shoveling manure, sweeping, and liming. The stalls in a stanchion barn are bedded with straw, sawdust, or shavings in the winter, but is not bedded during the summer when the cows are in the barn only for milking.

No information was obtained for cleaning loose run barns mechanically other than that the investigators at Wisconsin (6, p. 3) found the cleaning job added about 2.3 percent to the total of all other labor for the year.

Table 8. Time required for work elements of cleaning and bedding.

| Work element | Minutes | Per | Minutes | Per |
|---|---|---|---|---|
| Clean milking barn (or parlor) by hosing and sweeping | .0174 | sq. ft. | 1.5 | stall |
| Clean milking barn (or parlor) by scraping, sweeping, and liming | .067 | sq. ft. | 2.38 | stall |
| Clean milking barn (or parlor) by scraping and sweeping only | .062 | sq. ft. | 2.24 | stall |
| Lime milking barn | .0046 | sq. ft. | 0.14 | stall |
| Clean milking barn (or parlor) by using high pressure hose only | .0295 | sq. ft. | 3.74 | stall |
| Bed barn by breaking and spreading baled straw | .0107 | sq. ft. | 3.64 | bale |

Walking. One of the work elements that requires a great deal of a dairyman's chore time is walking from one place to another. Dairy work has especially high walking requirements because the chores are composed of a great number of short operations and these operations are usually at different places. The dairyman cannot walk to one place and do all the work that occurs there and then go to the next place and so on. Instead, he must walk back and forth again and again. Therefore, the walking time for various distances and loads was recorded and plotted. There was, of course, much inconsistency in the observations. By the method given in the Appendix, the data were condensed down into the form shown in Figs. 1 and 2. Figure 2 is only the part

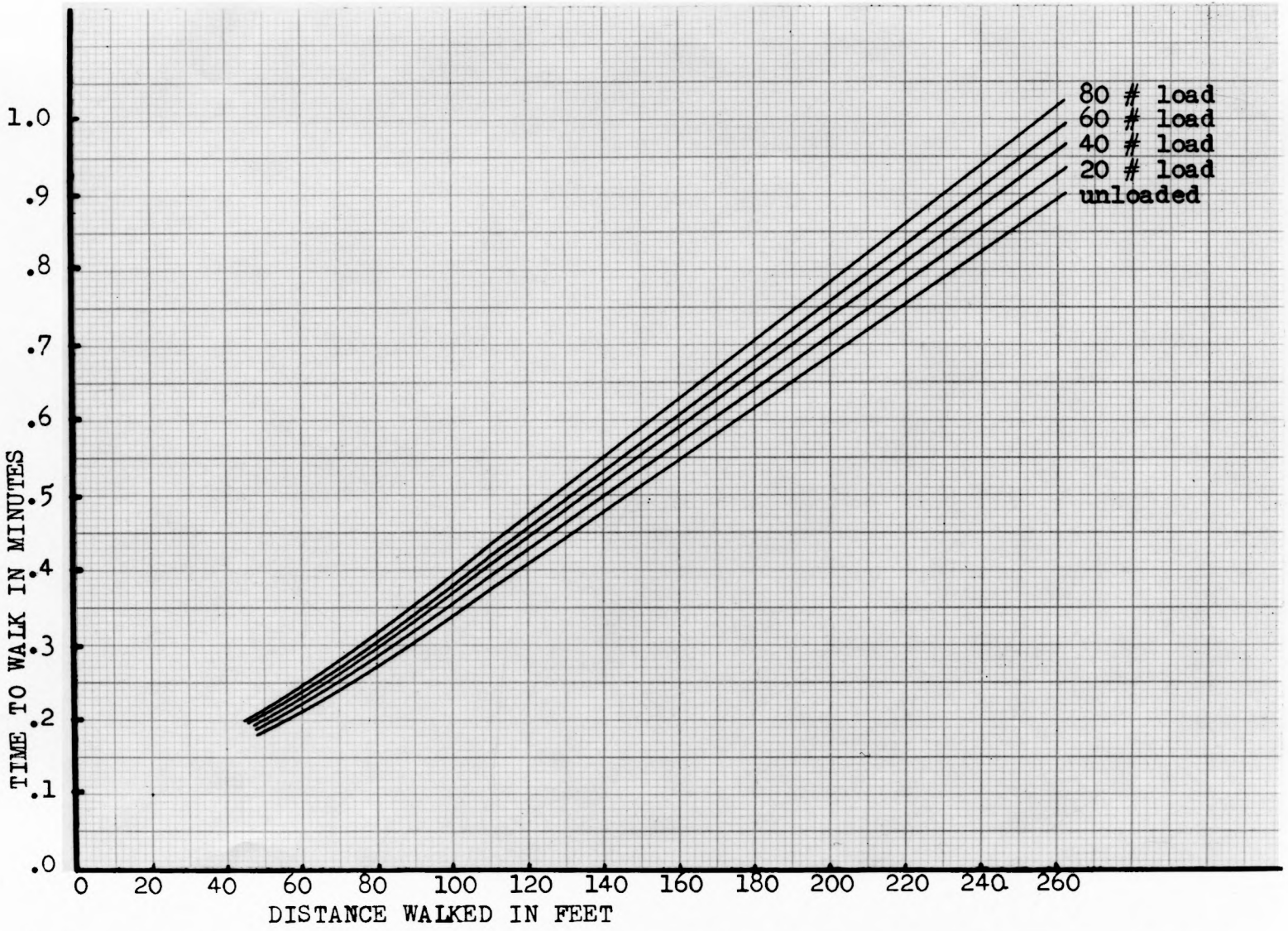



Figure 1. Time required for man to walk long distances and carry various loads.

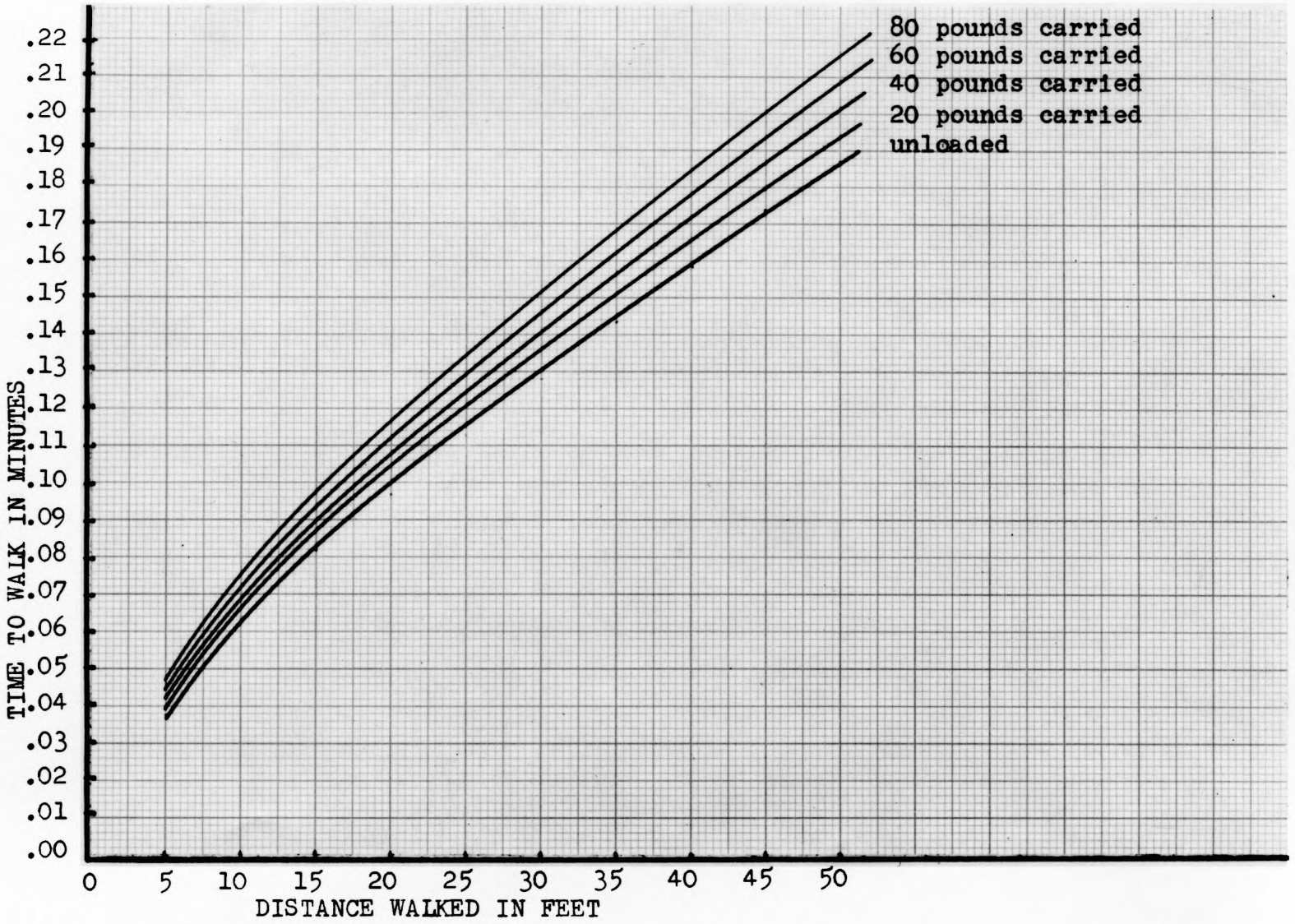



Figure 2. Time required for man to walk short distances and carry various loads.

of Fig. 1 below 50 feet expanded for ease in reading. The lower rate of walking for shorter distances appeared to be a matter of attitude in that the dairymen saw no reason to hurry if they were only going 20 feet. However, if the man had 200 feet to walk, he hurried to avoid spending a large amount of time.

## Time Requirements for Cows During the Milking Routine

Machine Time. Machine time is the period between attaching the milker and detaching it. This includes the time for machine stripping, but does not include the time for hand stripping. Table 9 shows the average machine time and milk per minute of machine time for 16 of the farms studied (cows were timed on only 16 farms).

Table 9. Average machine time for each farm studied.

| Farm | No. cows timed | Average machine time (minutes) | Average production (pounds) | Average pounds milk per minute machine time |
|---|---|---|---|---|
| 1 | 9 | 7.20 | 11.9 | 1.65 |
| 2 | 10 | 3.88 | 10.9 | 2.81 |
| 3 | 17 | 3.46 | 9.6 | 2.78 |
| 4 | 11 | 5.24 | 13.7 | 2.62 |
| 5 | 28 | 5.55 | 17.6 | 3.16 |
| 6 | 17 | 6.18 | 14.8 | 2.39 |
| 7 | 13 | 5.40 | 22.7 | 4.20 |
| 8 | 10 | 4.87 | 15.3 | 3.14 |
| 9 | 16 | 6.30 | 23.3 | 3.70 |

Table 9. (concl.).

| Farm | No. cows timed | Average machine time (minutes) | Average production (pounds) | Average pounds milk per minute machine time |
|---|---|---|---|---|
| 10 | 11 | 5.12 | 15.6 | 3.05 |
| 11 | 8 | 3.88 | 11.0 | 2.83 |
| 12 | 25 | 5.38 | 14.6 | 2.71 |
| 13 | 26 | 4.95 | 15.5 | 3.14 |
| 14 | 31 | 4.87 | 15.5 | 3.18 |
| 15 | 11 | 4.00 | 13.7 | 3.42 |
| 16 | 20 | 6.43 | 19.6 | 3.04 |
| Weighted averages | 16.4 | 5.23 | 15.75 | 3.01 |

It can be seen from Table 9 that very little uniformity of machine time existed even for the farms of approximately the same average production. The grand average of 5.23 minutes is somewhat higher than necessary. Figure 3 shows how machine time varied with production. This curve was obtained by plotting the record of each cow and drawing a curve by group averages at intervals. The original points were quite scattered, but the curve given is believed to be representative. This curve tends to agree with the investigators mentioned earlier who found that production does not greatly affect machine time other than for very low flows of milk. For the purpose of comparing milking barns, 40 minutes machine time was used because longer periods

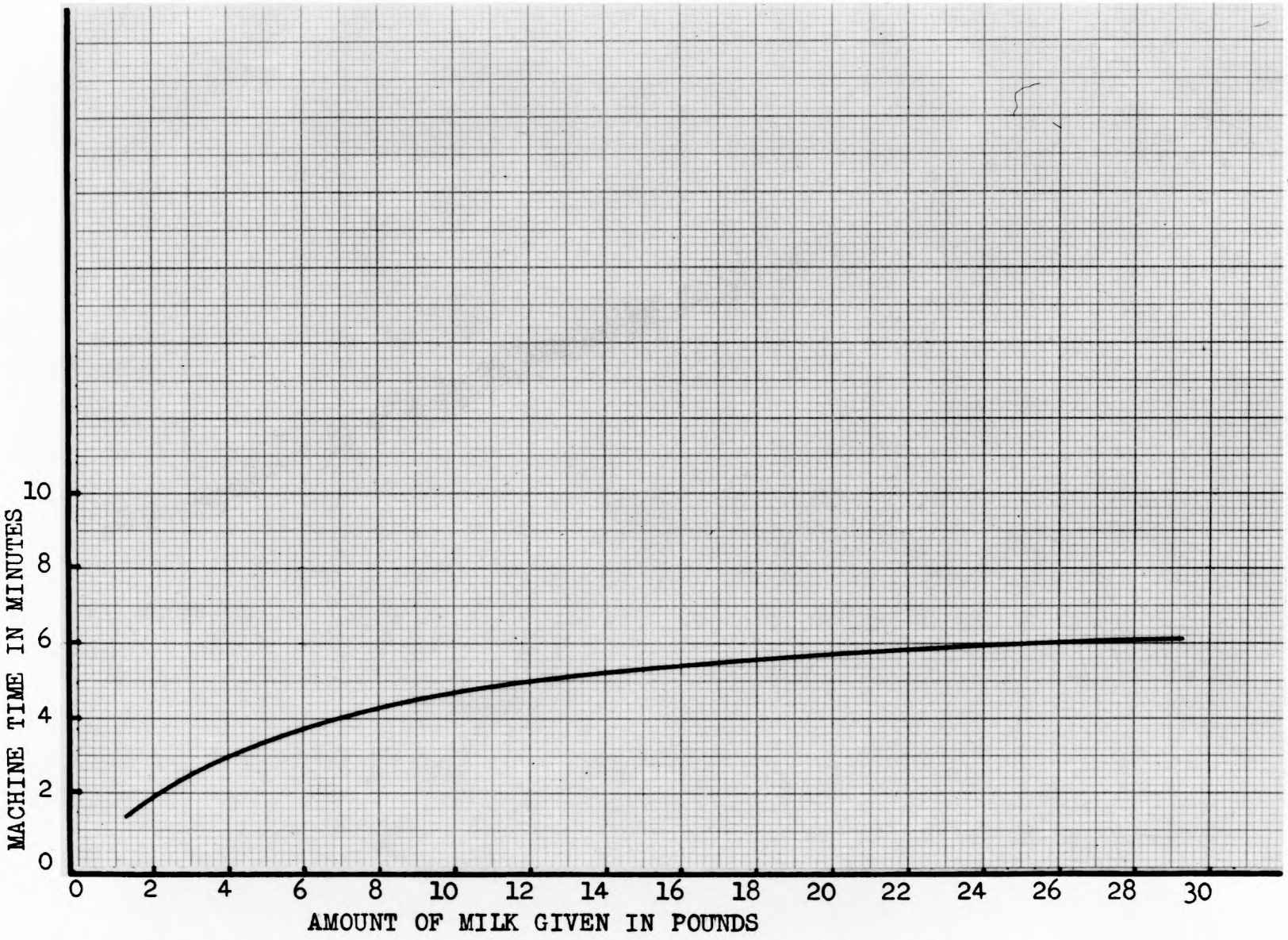



Figure 3. How machine time varies as flow of milk increases.

make the routine less difficult and because 4.0 minutes is the maximum recommended average machine time. The data given in table 9 show, however, that considerable time can be saved by a reduction of machine time to a recommended figure of around 4.0 minutes. Table 1 shows the average machine time found by other investigators to range from 5.1 to 8.5 minutes. A general statement can be made that milkers are left on the cow too long by practically all dairymen.

Grain Eating Time. Number of stalls in the parlor is chiefly determined by the length of time the cows require to eat their feed because a cow cannot eat a liberal grain ration in the time allowed for milking. Wilkins (21, p. 13) found the cows required about 1 minute for each pound of grain plus 1 minute. Table 10 gives herd averages for eating time for 14 of the herds visited; eating time was not recorded at the other farms.

Table 10. Rate of eating concentrate by dairy cows.

| Farm | No. cows | Pounds per cow | Minutes per cow | Minutes per pound eaten |
|---|---|---|---|---|
| 1 | 8 | 1.5 | 4.18 | 2.79 |
| 2 | 12 | 6.67 | 13.48 | 2.02 |
| 3 | 12 | 4.065 | 10.48 | 2.57 |
| 4 | 10 | 2.62 | 8.88 | 3.38 |
| 5 | 31 | 5.35 | 8.99 | 1.68 |
| 6 | 16 | 4.68 | 8.00 | 1.72 |
| 7 | 6 | 4.50 | 11.79 | 2.62 |

Table 10. (concl.).

| Farm | No. cows | Pounds per cow | Minutes per cow | Minutes per pound eaten |
|---|---|---|---|---|
| 8 | 9 | 3.66 | 7.55 | 2.06 |
| 9 | 19 | 5.09 | 12.35 | 2.42 |
| 10 | 7 | 7.19 | 13.18 | 1.83 |
| 11 | 9 | 5.12 | 8.80 | 1.72 |
| 12 | 25 | 4.84 | 6.38 | 1.32 |
| 13 | 11 | 3.0 | 10.75 | 3.59 |
| 14 | 20 | 2.28 | 12.26 | 5.36 |
| Grand average | | 4.42 | 9.68 | 2.19 |

Figure 4 shows the curve resulting from the figures in Table 10 (Appendix A). It is to be noted that the time required is considerably greater than the time calculated by Wilkins' (21, p. 13) rule of one minute per pound plus a minute. Since the use of Fig. 4 results in a greater time to eat the grain, the curve shown was used to determine eating time instead of the time required by the above rule.

Rate of Walking for Cows. Since the cows must be brought into the parlors (by driving or voluntarily), an important piece of information is the rate of travel of a cow when walking short distances at a normal pace. This information is presented in Fig. 5 which was obtained by calculating the best-fit-line that passed through the origin (Appendix B). Of less value in milking

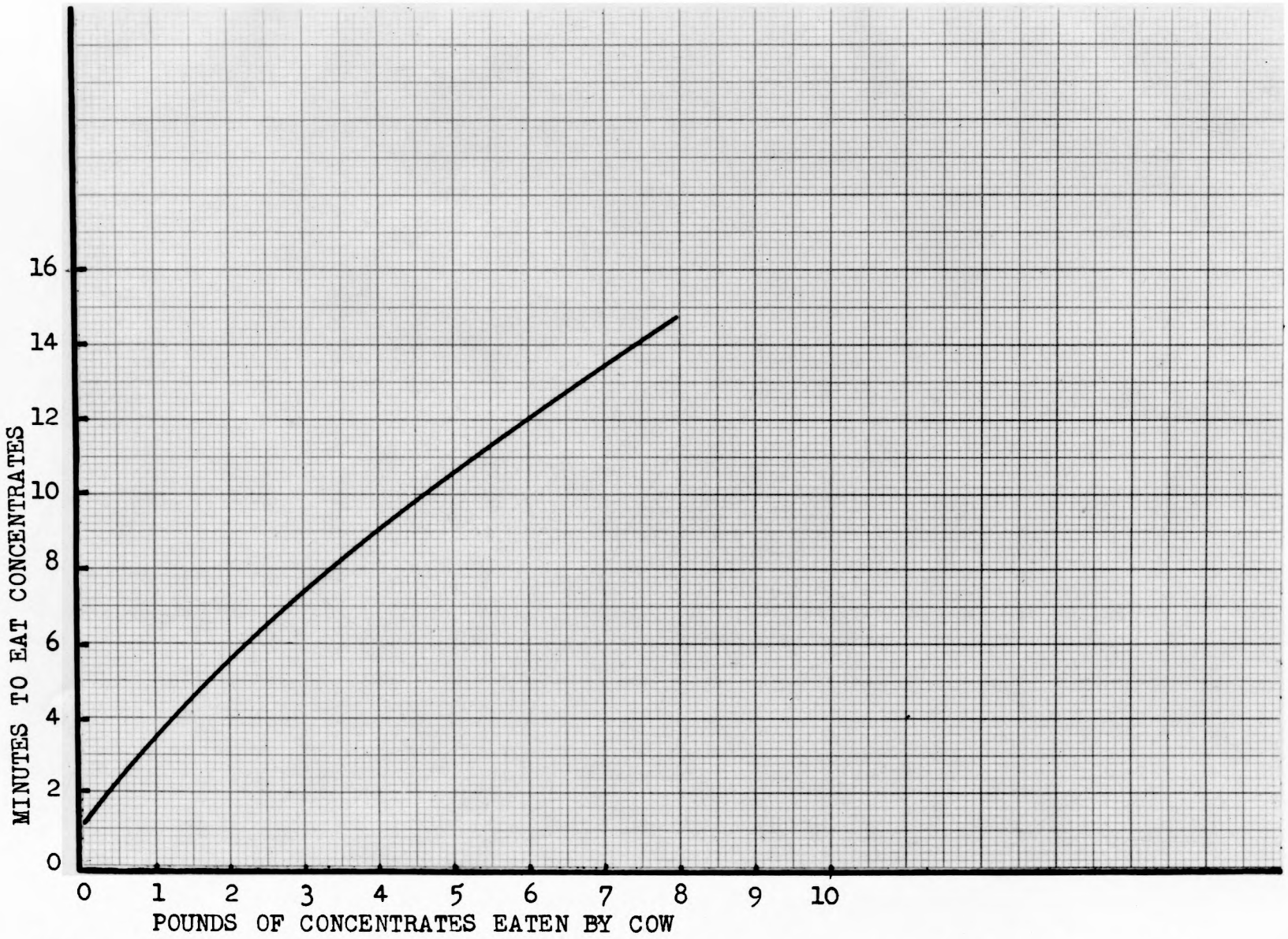



Figure 4. Time required by dairy cows to eat concentrates while being milked.

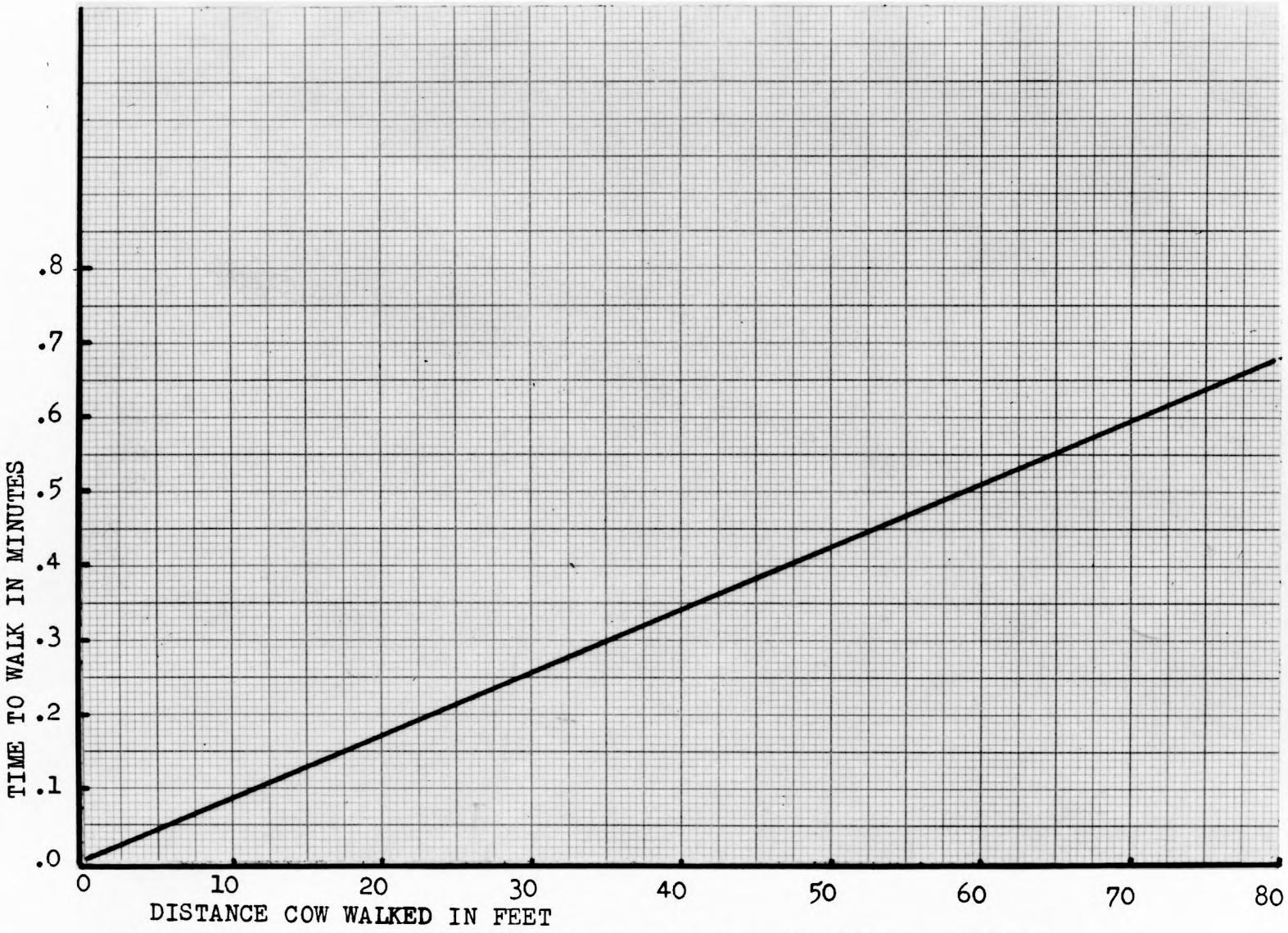



Figure 5. Time required for dairy cows to walk short distances.

routine but still of value is the rate cows walk longer distances. Figure 6 is the best-fit-line of only a few observations.

Time Spent in Stalls on Farms Studied. On some farms an observer recorded everything that happened at the milking stall to learn how the distribution of actual time-in-stall was being effected on existing dairy farms. Table 11 gives this information.

Table 11. Distribution of time-in-stall for dairy cows on farms studied.

| Farm | No. of cows | Av. time before milker attached (min.) | Av. mach. time (min.) | Av. time in stall after mach. detached (min.) | Av. stripping time (min.) | Av. total time in stall (min.) |
|---|---|---|---|---|---|---|
| 12 | 25 | 0.875 | 5.38 | 0.145 | Included in mach. time (machine stripped) | 6.4 |
| 13 | 26 | 1.81 | 4.92 | 1.39 | Included in mach. time (machine stripped) | 8.12 |
| 14 | 31 | 1.21 | 4.86 | 2.07 | 0.86 | 8.14 |
| 17 | 15 | 0.54 | 4.857 | 0.17 | Included in mach. time (machine stripped) | 5.56 |
| Weighted average | | 1.18 | 5.02 | .641 mach. str. 2.07 hand str. | 0.86 | 7.3 |

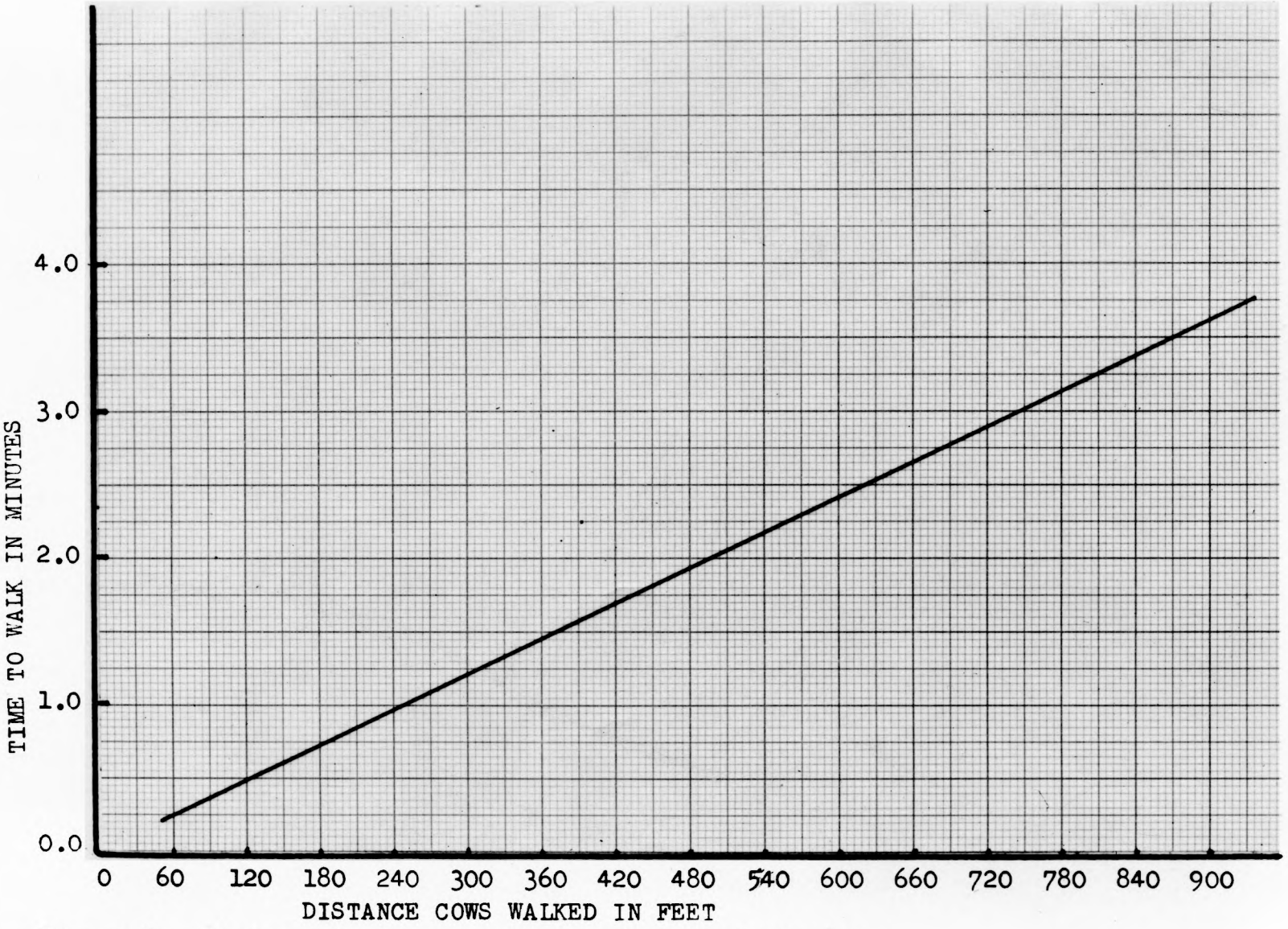



Figure 6. Time required for cows to walk long distances.

# COMPARISONS OF BUILDINGS, EQUIPMENT, AND METHODS

## Milking Barns

Milking barns were compared as to time required for the milking operation for a 30-cow herd. Feeding time was added to the milking time for the stanchion barn to make it comparable to the parlors. For each barn the following constants were assumed: (a) 4.0 minutes machine time, (b) machine strip the last 1/2 minute of the 4.0 minutes machine time, (c) cows give 20 pounds of milk per milking, (d) 5 pounds of grain is fed per cow per milking, (e) 1 minute between washing udder and attaching machine, (f) cow door opened by ropes where applicable, (g) grain stored in boxes near stalls for feeding where applicable. Barns compared were as follows:

In the tandem parlor (Plate 1, Fig. 7, Table 12, and Table 12-a), the cows are brought in one at a time (after the initial three cows) and walk down the cow alley to the stall that is open. Cows leave singly by going out the front gate of the stall and on out to the discharge lot. Cow doors are operated by the operator from his pit by ropes and pulleys. This plan is dependent on the cows entering voluntarily if one man is to operate it.

## EXPLANATION OF PLATE I

View of a 3-stall tandem parlor from one end of the operator's pit. The floor level of the operator's pit is about 30 inches lower than the floor level of the stalls and cow alley to the right of the row of stalls. The sacks hung on the wall on the left contain feed weighed out in advance for each cow. The floor of the operator's pit was covered with asphalt concrete which provided a very non-slip surface. Most operators did not like the type of window shown here because very little air entered on a warm, windless evening.

PLATE I

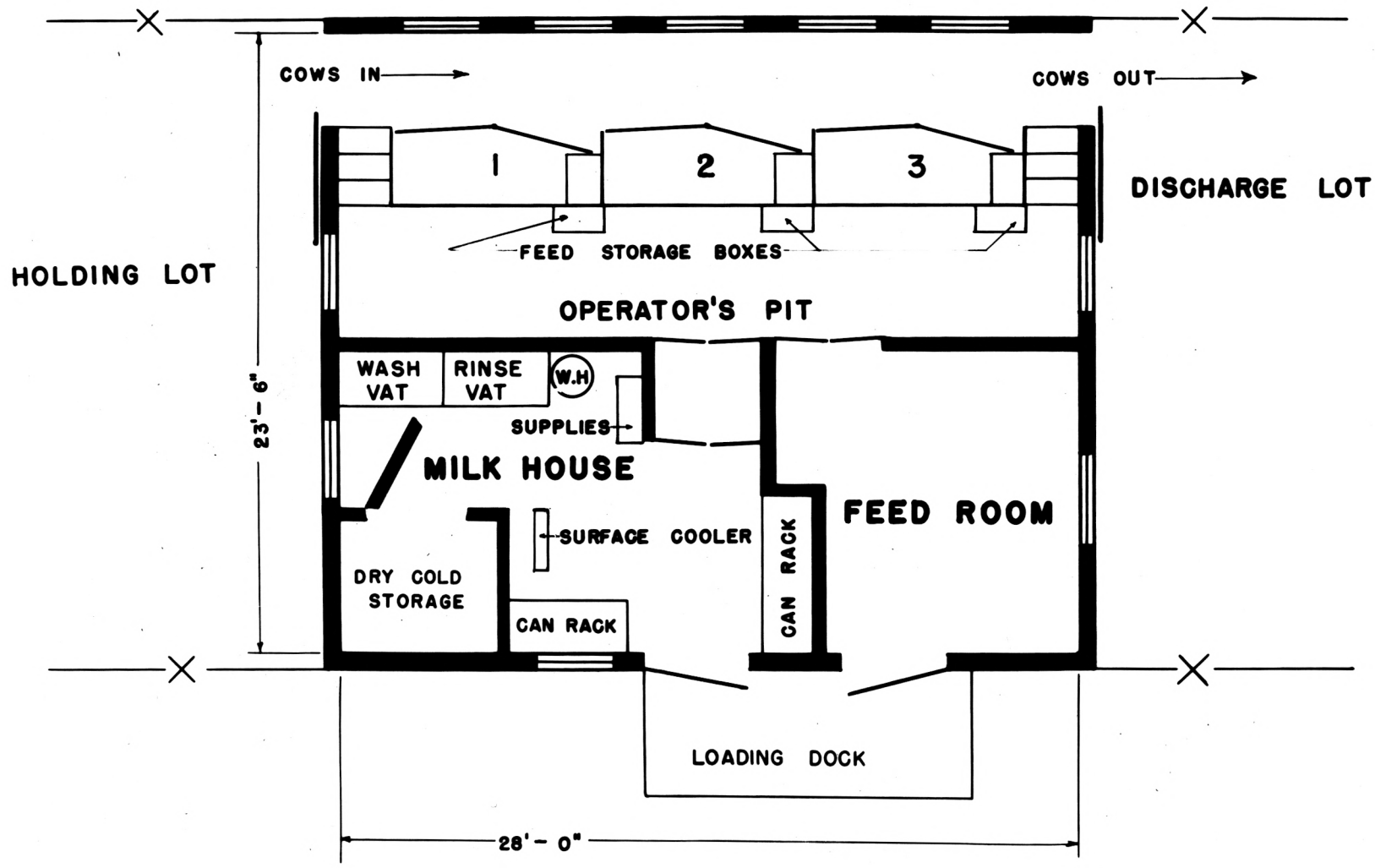



Fig. 7. 3-stall tandem milking parlor.

Table 12. Time routine for 3-stall tandem parlor (Plate I and Fig. 7) using 2 bucket milkers with spare milker pail and with cows entering voluntarily.

| Work done | Dist. | Time | | | Milker location at end of work | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Start | End | Elapsed | A | B | |
| Carry 2 milkers and extra pail to cow door rope..... | 10' | 0.0 | .068 | .068 | Center of pit | Center of pit | |
| Open cow door and let 3 cows in stalls | 42' (cow) | .068 | .428 | .36 | " | " | Closes gates on 1 and 2 while 3 goes to stall |
| Walk and feed 3 cows grain..... | 16' | .428 | 1.216 | .788 | " | " | |
| Walk to get udder wash and teat cup rinse pails..... | 20' | 1.216 | 1.316 | .10 | " | " | Need 2 pails teat cup rinse water and 1 pail udder wash water at ea. stall |
| Carry 9 pails to faucet near center of pit..... | 15' | 1.316 | 1.403 | .087 | " | " | |
| Run 9 pails water and put chlorine powder in 6..... | - | 1.403 | 5.003 | 3.60 | " | " | |
| Wash udder (for milker A)..... | 0 | 5.003 | 5.226 | .223 | " | " | |

Table 12. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| Attach milker A (stall 2)..... | 0 | 6.00 | 6.37 | .37 | Stall 2 | Center of pit | Machine strip about 9.87 |
| Walk and wash udder for milker B..... | 8' | 7.40 | 7.675 | 2.275 | " | " | |
| Attach milker B (stall 1)..... | 0 | 8.40 | 8.77 | .37 | " | Stall 1 | Machine strip about 12.270 |
| "A" job group (see Table 12-a)..... | - | 9.647 | 11.800 | 2.153 | Stall 3 | " | Machine strip about 14.627 |
| ...First cycle | | | | | | | |
| "B" job group..... | - | 12.047 | 14.200 | 2.153 | S " | Stall 2 | Machine strip about 17.027 |
| "A" job group..... | - | 14.404 | 16.557 | 2.153 | Stall 1 | " | |
| ...Second cycle | | | | | | | |
| "B" job group..... | - | 16.804 | 18.957 | 2.153 | " | Stall 3 | |

These cycles continue till 30 cows are milked
Time to fill feed storage boxes with cart = 3.145

Summary

Cycle time = 4.757 min. for 2 cows milked, of which .451 is waiting.
= 2.738 min. per cow or 25.2 cows per man hour.
= 71.4 min. for 30 cows.
Starting time = 9.647 min. (from start to beginning of cycles).
Time to clean barn = 5.6 min. (322 sq. ft. at .0174 min./sq. ft.
Time to fill boxes = 3.865 min.
Total time = 90.512 min.
= 3.017 min./cow or 19.9 cows/man hour

Table 12-a. Job group for 3-stall tandem parlor (Plate I and Fig. 7). Job group repeated for every cow.

| Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|
| Wash udder..... | 0.0 | 0.223 | 0.223 | 0 | At stall where mlkr. goes next |
| Walk and machine strip..... | 0.223 | 0.793 | 0.570 | 12' | Dist. is av. |
| Detach mlkr., dip teat cups, and transfer head to spare mlkr. pail... | 0.793 | 1.031 | 0.238 | 0 | |
| Walk and attach mlkr..... | 1.031 | 1.480 | 0.449 | 12' | Dist. is av. |
| Walk and change cows in stall..... | 1.480 | 1.77 | 0.29 | cow 34' | Feed grain while changing. Dists. av. |
| Carry spare pail of milk to surface cooler..... | 1.770 | 1.878 | 0.108 | 20' | Dist. is av. |
| Dump pail of milk into surface cooler strainer..... | 1.878 | 2.099 | 0.171 | 0 | |
| Carry spare pail from surface cooler to stall..... | 2.049 | 2.153 | 0.104 | 20' | Dist. is av. |

Total job group time = 2.153 minutes.

The 5-stall tandem parlor (Fig. 8, Table 13, and Table 13-a) operate similarly to the 3-stall tandem previously described except that there are more stalls.

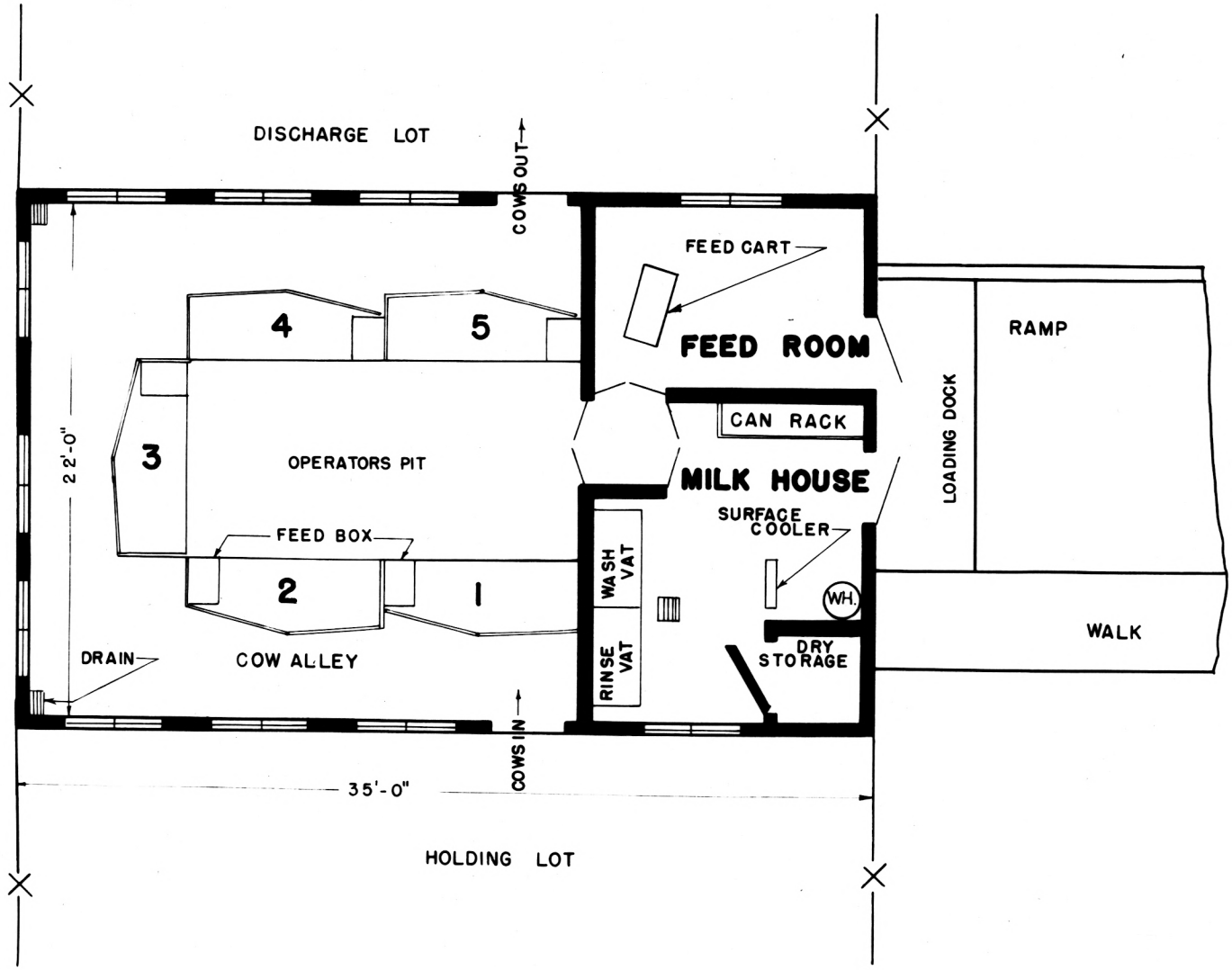



Fig. 8. 5-stall tandem milking parlor.

Table 13. Time routine for 5-stall tandem parlor (Fig. 8) using 2 bucket milkers with spare milker pail and with cows entering voluntarily.

| Work done | Dist. | Time | | | Milker location at end of work | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Start | End | Elapsed | A | B | |
| Carry 2 mlkrs. and extra pail from M. H. to cow door rope at center of pit..... | 18' | 0.0 | 0.102 | 0.102 | Center of pit | Center of pit | Closes gates as cows go into stalls |
| Open cow door and let 5 cows in stalls | 74' (cow) | 0.102 | 0.762 | 0.66 | " | " | |
| Walk and feed 5 cows grain..... | 32' | 0.762 | 2.058 | 1.306 | " | " | |
| Walk to get 3 udder wash and 6 teat cup rinse pails..... | 22' | 2.068 | 2.174 | 0.106 | " | " | Need 3 udder wash and 6 teat cup rinse pails |
| Carry 9 pails to faucet on wall opposite wash vat... | 14' | 2.174 | 2.258 | 0.084 | " | " | |
| Run 9 pails of water and add chlorine powder..... | - | 2.258 | 5.858 | 3.60 | " | " | Distribute pails while running others |
| Wash udder for milker A..... | 0 | 5.858 | 6.081 | 0.223 | " | " | |

Table 13. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| Attach milker A..... | 0 | 6.90 | 7.27 | 0.37 | Stall 1 | Center of pit | Machine strip about 10.77 |
| Walk and wash udder for milker B..... | 16' | 8.28 | 8.589 | 0.309 | " | " | |
| Attach milker B..... | 0 | 9.28 | 9.65 | 0.37 | " | Stall 3 | Machine strip about 13.170 |
| "A" job group (see Table 13-a)..... | - | 10.547 | 12.803 | 2.256 | Stall 2 | " | |
| ...First cycle | | | | | | | |
| "B" job group..... | - | 12.927 | 15.183 | 2.256 | " | Stall 4 | |
| "A" job group..... | - | 15.304 | 17.560 | 2.256 | Stall 5 | " | |
| ...Second cycle | | | | | | | |
| "B" job group..... | - | 17.684 | 19.940 | 2.256 | " | Stall 1 | |

These cycles continue until 30 cows are milked
Time to fill feed storage boxes with cart = 5.147 min.

Summary

Cycle time = 4.757 min. for 2 cows milked, of which .245 is waiting.
= 2.378 min. per cow or 25.2 cows per man hour.
= 71.4 min. for 30 cows.

Table 13. (concl.).

Summary
(concl.)

| | |
|---|---|
| Starting time | = 10.547 minutes. |
| Time to clean barn | = 8.23 (473 sq. ft. at .0174 min./sq. ft. |
| Time to fill feed boxes | = 5.147 min. |
| Total time | = 95.342 min. |
| | = 3.177 min./cow or 18.9 cows/man hour. |

Table 13-a. Job group for 5-stall tandem parlor (Fig. 8). Job group repeated for each cow.

| Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|
| Wash udder..... | 0.0 | 0.223 | 0.223 | 0 | At stall where mlkr. goes next |
| Walk and machine strip..... | 0.223 | 0.793 | 0.570 | 12' | Dist. is av. |
| Detach mlkr., dip teat cups, and transfer head to spare pail..... | 0.793 | 1.031 | 0.238 | 0 | |
| Walk and attach mlkr..... | 1.031 | 1.480 | 0.449 | 12' | Dist. is av. |
| Walk and change cows in stall..... | 1.480 | 1.865 | 0.385 | cow 44' | Dists. av. Cow fed during change |
| Carry spare pail of milk to surface cooler..... | 1.865 | 1.977 | 0.112 | 21' | Dist. is av. |
| Dump pail of milk into surface cooler strainer... | 1.977 | 2.148 | 0.171 | 0 | |
| Carry spare pail from surface cooler to stall... | 2.148 | 2.256 | 0.108 | 21' | Dist. is av. |

Total job group time = 2.256 minutes.

In the 4-stall Montana parlor (Fig. 9, Fig. 10, Table 14-a), the cows can be herded in either singly if they will enter voluntarily or in groups if they must be driven. The cows face the operator's pit and must back out. Figure 10 shows the type stall used in the Montana type parlor.

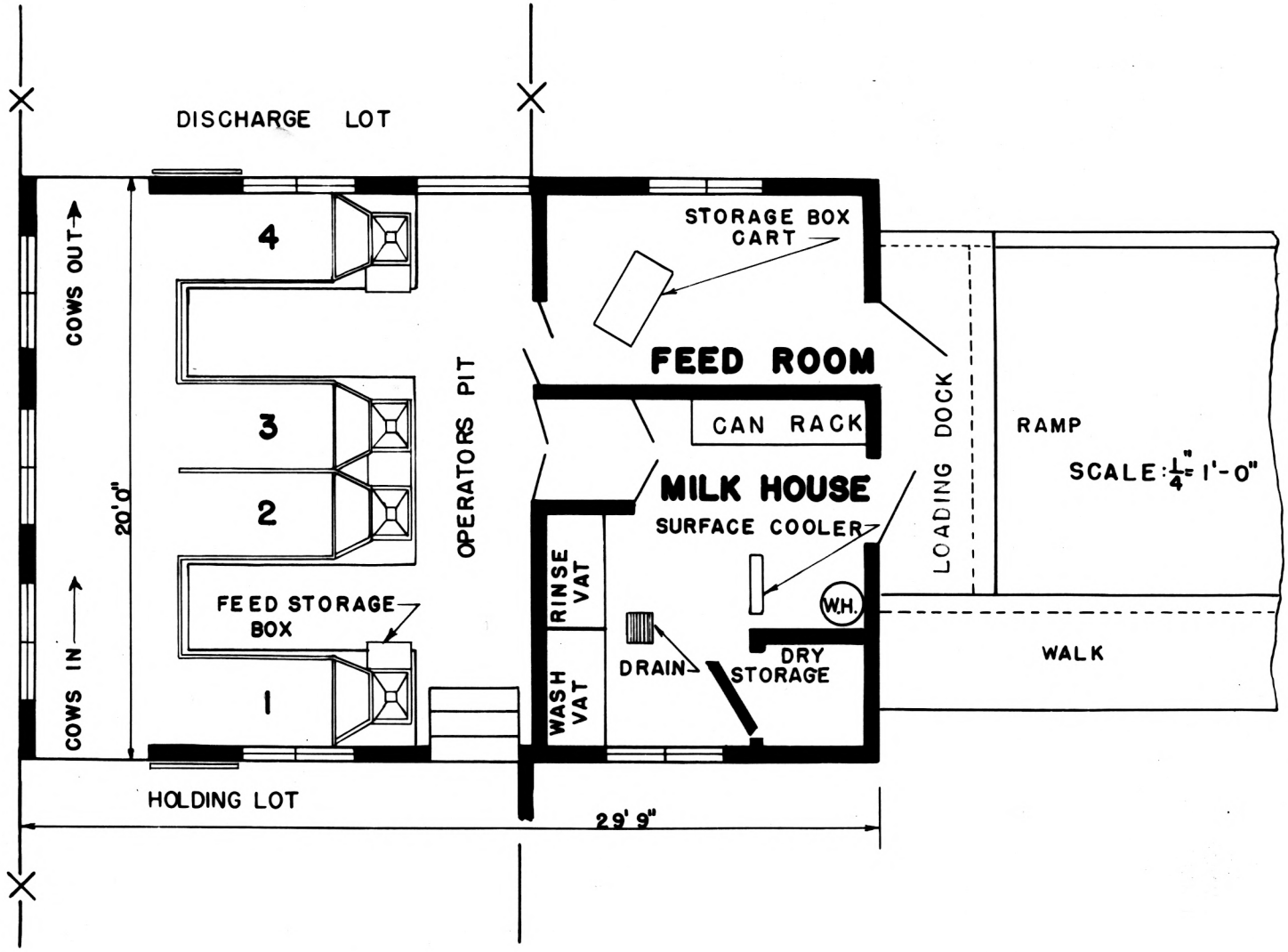



Fig. 9. 4-stall Montana milking parlor.

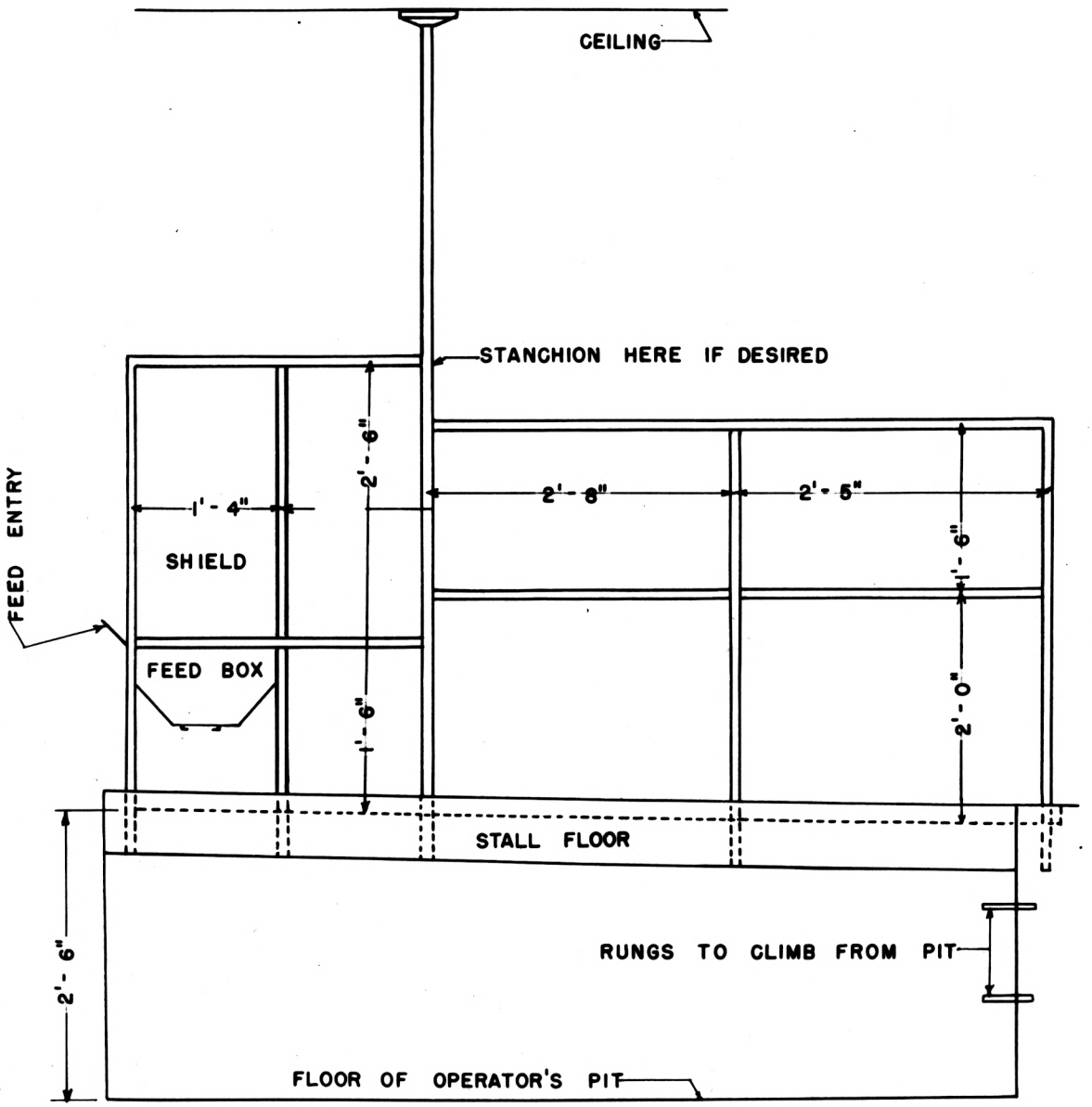



Fig. 10. Type of stall used in Montana parlors.

Table 14. Time routine for 4-stall Montana parlor (Fig. 9) using 2 bucket milkers with a spare pail and cows entering voluntarily one at a time.

| Work done | Dist. | Time | | | Milker location at end of work | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Start | End | Elapsed | A | B | |
| Carry milkers and extra pail to cow door rope..... | 11' | 0.0 | 0.076 | 0.076 | Center of pit | Center of pit | |
| Open cow door and let 4 cows in stalls..... | 50' (cow) | 0.076 | 0.501 | 0.425 | " | " | |
| Walk to each stall, feed and latch ea. cow..... | 12' | 0.501 | 1.668 | 1.167 | " | " | |
| Walk to get udder wash and teat cup rinse pails..... | 20' | 1.668 | 1.768 | 0.10 | " | " | Need 1 udder wash and 2 teat cup rinse pails between ea. pair of stalls |
| Carry 6 pails to center of pit (faucet there)..... | 16' | 1.768 | 1.858 | 0.09 | " | " | |
| Run 6 pails of water, add chlorine powder and distribute pails | - | 1.858 | 4.258 | 2.40 | " | " | Add chlorine powder and distribute pails while water is running |
| Wash udder for mlkr. A..... | 0 | 4.258 | 4.481 | 0.223 | " | " | |

Table 14. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| Attach milker A..... | 0 | 5.30 | 5.67 | 0.37 | Stall 1 | Center of pit | Machine strip about 9.17 |
| Walk and wash udder for milker B..... | 26' | 6.70 | 7.041 | 0.341 | " | " | |
| Attach milker B..... | 0 | 7.604 | 7.974 | 0.37 | " | Stall 3 | Machine strip about 11.474 |
| "A" job group (see Table 14-a)..... | - | 8.947 | 11.134 | 2.187 | Stall 2 | " | Machine strip about 13.778 |
| ...First cycle | | | | | | | |
| "B" job group..... | - | 11.251 | 13.438 | 2.187 | " | Stall 4 | Machine strip about 16.082 |
| "A" job group..... | - | 13.555 | 15.742 | 2.187 | Stall 1 | " | |
| ...Second cycle | | | | | | | |
| "B" job group..... | - | 15.859 | 18.046 | 2.187 | " | Stall 3 | |

These cycles continue until 30 cows are milked.
Time to fill feed storage boxes with car = 3.655 min.

Summary

Cycle time = 4.608 min. for 2 cows milked, of which .234 is waiting.
= 2.304 min. per cow or 26.0 cows/man hour.
= 69.1 min. for 30 cows.

Table 14. (concl.).

Summary
(concl.)

| | | |
|---|---|---|
| Starting time | = | 8.947 minutes (from start to beginning of cycles). |
| Time to clean parlor | = | 5.61 minutes (323 sq. ft. at .0174 min./sq. ft.). |
| Time to fill boxes | = | 3.655 minutes. |
| Total time | = | 87.312 minutes |
| | = | 2.91 man min./cow = 20.6 cows/man hour. |

Table 14-a. Job group for 4-stall Montana parlor (Fig. 9) of group repeated for every cow. Cows enter voluntarily singly.

| Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|
| Wash udder..... | 0.0 | 0.223 | 0.223 | 0 | At stall where mlkr. goes next. |
| Machine strip..... | 0.223 | 0.723 | 0.500 | 0 | |
| Detach mlkr, dip teat cups, and transfer head to spare mlkr. pail... | 0.723 | 0.961 | 0.238 | 0 | |
| Attach milker..... | 0.961 | 1.331 | 0.37 | 0 | |
| Change cow (singly) | 1.331 | 1.788 | 0.457 | cow 41' | Fed while changing. Dist. is av. |
| Carry spare pail of milk to surface cooler..... | 1.788 | 1.904 | 0.116 | 23' | Dist. is av. |
| Dump pail of milk into surface cooler strainer.... | 1.904 | 2.075 | 0.171 | 0 | |
| Carry spare pail from surface cooler to stall..... | 2.075 | 2.187 | 0.112 | 23' | Dist. is av. |

Total job group time = 2.187 minutes.

Operation of the 6-stall Montana parlor (Fig. 11, Table 15, and Table 15-a), is the same as for 4-stall Montana except that two holding lots are needed and the herd must be divided. This could also be operated with one holding lot and two discharge lots by making a door from the pit to what is shown in Fig. 11 as the discharge lot and using this as the holding lot.

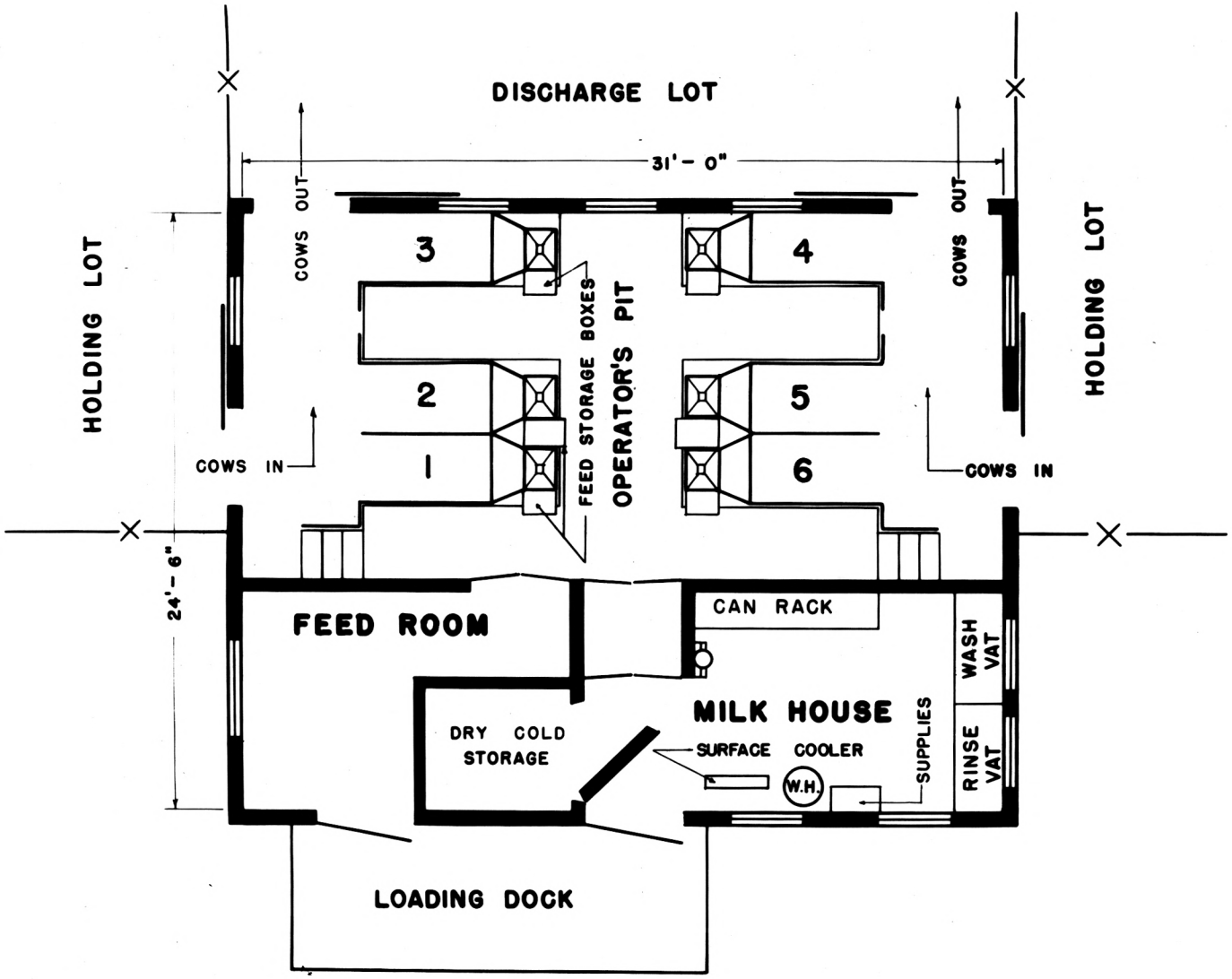



Fig. 11. 6-stall Montana milking parlor.

Table 15. Time routine for 6-stall Montana parlor (Fig. 11) using 2 bucket milkers with a spare pail and cows entering voluntarily by groups of 3.

| Work done | Dist. | Time | | | Milker location at end of work | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Start | End | Elapsed | A | B | |
| Carry milkers and extra pail to cow door rope..... | 25' | 0.0 | 0.126 | 0.126 | Center of pit | Center of pit | |
| Open cow doors and let 6 cows in stalls..... | 62' (cow) | 0.126 | 0.686 | 0.560 | " | " | |
| Walk to each stall, feed and latch cows..... | 50' | 0.686 | 2.516 | 1.830 | " | " | |
| Walk to get udder wash and teat cup rinse pails..... | 18' | 2.516 | 2.609 | 0.093 | " | " | Need 1 udder wash and 2 teat cup rinse pails at ea. mlkr. position. Faucet near center of pit |
| Carry 12 pails to center of pit..... | 23' | 2.609 | 2.725 | 0.116 | " | " | |
| Run 12 pails of water, add chlorine powder and distribute pails..... | - | 2.725 | 7.525 | 4.8 | " | " | Add chlorine and distribute pails while pails are filled |
| Wash udder for mlkr. A..... | 0 | 7.525 | 7.748 | 0.223 | " | " | |

Table 15. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| Attach milker A..... | 0 | 8.50 | 8.87 | 0.37 | Stall 2 | Center of pit | Machine strip about 12.37 |
| Walk and wash udder for milker B..... | 0 | 9.860 | 10.083 | 0.223 | " | " | |
| Attach milker B..... | 0 | 10.895 | 11.265 | 0.37 | " | Stall 3 | Machine strip about 14.765 |
| "A" job group (see table 15-a)..... | - | 12.147 | 14.453 | 2.306 | Stall 1 | " | Machine strip about 17.157 |
| ...First cycle | | | | | | | |
| "B" job group..... | - | 14.592 | 16.848 | 2.306 | " | Stall 4 | Machine strip about 19.552 |
| "A" job group..... | - | 16.934 | 19.240 | 2.306 | Stall 6 | " | |
| ...Second cycle | | | | | | | |
| "B" job group..... | - | 19.329 | 21.635 | 2.306 | " | Stall 5 | |

These cycles continue until 30 cows are milked.
Time to fill feed storage boxes = 4.502 min.

Summary

Cycle time = 4.787 min. for 2 cows milked, of which .175 min. is waiting.
= 2.393 min. per cow or 25.1 cows/man hour.
= 75.2 min. for 30 cows.

Table 15. (concl.).

Summary
(concl.)

| | | |
|---|---|---|
| Starting time | = | 12.147 min. (from start to beginning of cycles). |
| Time to clean parlor | = | 8.091 min. (465 sq. ft. at .0174 min/sq. ft.). |
| Time to fill feed boxes | = | 4.502 min. |
| Total time | = | 99.94 min. for 30 cows. |
| | = | 3.331 min. per cow or 18.0 cows/man hour. |

Table 15-a. Job group for 6-stall Montana parlor (Fig. 11); repeated for every cow. Cows enter voluntarily by groups of 3.

| Work element | Time | | | Dist. | Remarks |
|---|---|---|---|---|---|
| | Start | End | Elapsed | | |
| Wash udder..... | 0.0 | 0.223 | 0.223 | 0 | At stall where mlkr. goes next |
| Walk and machine strip..... | 0.223 | 0.806 | 0.583 | 15' | Dist. is av. |
| Detach mlkr., dip teat cups, and transfer head to spare milker pail.. | 0.806 | 1.044 | 0.238 | 0 | |
| Carry and attach milker..... | 1.044 | 1.510 | 0.466 | 15' | Dist. is av. |
| Change cow (by 3's) in stall. Cow fed during change..... | 1.510 | 1.890 | 0.380 | - | Values here are 1/3 of ea. change |
| Carry spare pail of milk to surface cooler..... | 1.890 | 2.015 | 0.125 | 25' | Dist. is av. |
| Dump milk into surface cooler strainer | 2.015 | 2.186 | 0.171 | 0 | |
| Carry spare pail to stall..... | 2.186 | 2.306 | 0.12 | 25' | |

Total job group time = 2.306 minutes.

The walk-through parlor has no pit. The cows enter the rear of the stall and leave through the side when the operator opens the gate on the side (Fig. 12, Table 16, and Table 16-a). The usual walk-through parlor is somewhat different from the one shown in Fig. 12 in that no operator's alley is normally placed between pairs of cows.

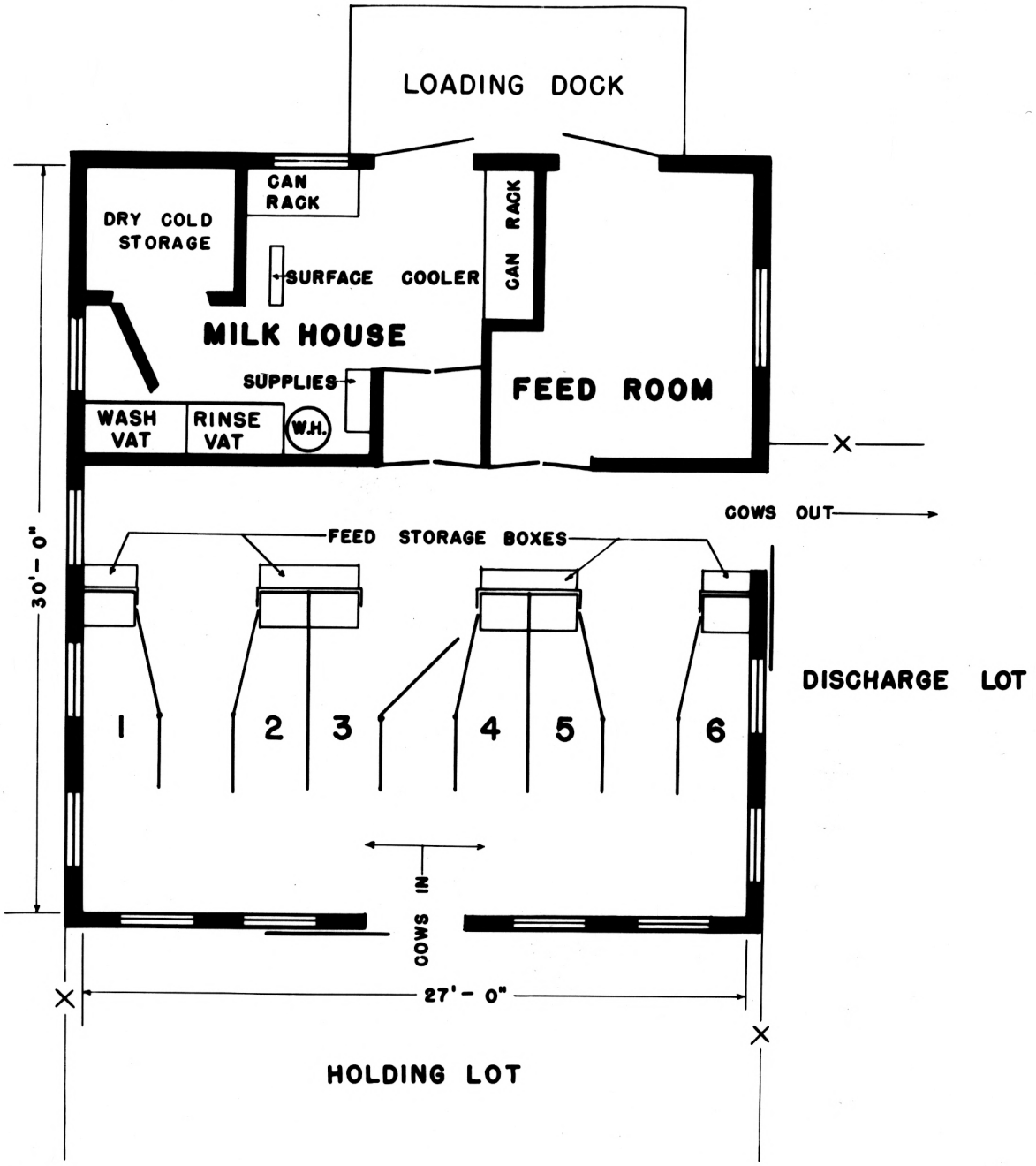



Fig. 12. 6-stall walk-through milking parlor.

Table 16. Time routine for 6-stall walk-through parlor (Fig. 12) using 2 bucket milkers with a spare pail and cows entering voluntarily by groups of 3.

| Work done | Dist. | Time | | | Milker location at end of work | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Start | End | Elapsed | A | B | |
| Carry milkers and extra pail to cow door rope..... | 27' | 0.0 | 0.163 | 0.163 | Between stalls 1 & 2 | Between stalls 1 & 2 | Space between ea. pair of stalls has cow door rope pull |
| Open cow door and let 6 cows in stalls | 120' (cow) | 0.163 | 1.203 | 1.04 | " | " | |
| Carry milker B to space between stalls 3 and 4..... | 10' | 1.203 | 1.269 | 0.066 | " | Between stalls 3 & 4 | |
| Walk and feed each cow grain..... | 44' | 1.269 | 2.843 | 1.574 | " | " | |
| Walk to get udder wash and teat cup rinse pails..... | 28' | 2.843 | 2.968 | 0.125 | " | " | Need 1 udder wash and 2 teat cup rinse pails at ea. pair of stalls |
| Carry 9 pails to faucet opposite wash vat..... | 20' | 2.968 | 3.073 | 0.105 | " | " | |

Table 16. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| Run 9 pails water, add chlorine powder and distribute pails..... | - | 3.073 | 6.673 | 3.60 | Between stalls 1 & 2 | Between stalls 3 & 4 | Add chlorine and distribute pails while pails filled |
| Wash udder for milker A..... | 0 | 6.673 | 6.896 | 0.223 | " | " | |
| Attach milker A.... | 0 | 7.40 | 7.77 | 0.37 | Stall 1 | " | Machine strip[1] about 11.470 |
| Walk and wash udder for milker B..... | 12' | 8.80 | 9.095 | 0.295 | " | " | |
| Attach milker B.... | 0 | 9.864 | 10.234 | 0.37 | " | Stall 3 | Machine strip[1] about 13.934 |
| "A" job group (see Table 16-a)..... | - | 11.247 | 13.689 | 2.442 | Stall 2 | " | Machine strip[1] about 16.398 |
| ...First cycle | | | | | | | |
| "B" job group..... | - | 13.711 | 16.153 | 2.442 | " | Stall 4 | Machine strip[1] about 18.862 |
| "A" job group..... | - | 16.175 | 18.617 | 2.442 | Stall 5 | " | |
| ...Second cycle | | | | | | | |
| "B" job group..... | - | 18.639 | 21.081 | 2.442 | " | Stall 5 | |

[1]Had to use 3.7 mins. between attach and machine strip because job gp. time was so long.

Table 16. (concl.).

These cycles continue till 30 cows are milked.
Time to fill feed storage boxes = 4.604

Summary

| | | |
|---|---|---|
| Cycle time = | 4.928 min. | for cows milked, of which .044 min. is waiting. |
| = | 2.464 min. | per cow or 24.3 cows/man hour. |
| = | 74.0 min. | for 30 cows. |
| Starting time = | 9.10 min. | (start to beginning of cycles). |
| Time to clean parlor = | 8.45 min. | (486 sq. ft. at .0174 min./sq. ft.). |
| Time to fill feed boxes = | 4.604 min. | |
| Total = | 96.154 min. | = 3.20 min/cow or 18.75 cows/man hour. |

Table 16-a. Job group for 6-stall walk through parlor (Fig. 12). Job group repeated for every cow. Cows enter voluntarily by groups of 3.

| Work element | Time | | | Dist. | Remarks |
|---|---|---|---|---|---|
| | Start | End | Elapsed | | |
| Wash udder..... | 0.0 | 0.223 | 0.223 | 0 | At stall where mlkr. goes next |
| Walk and machine strip..... | 0.223 | 0.781 | 0.558 | 9' | Dist. is av. |
| Detach milker, dip teat cups, and transfer head to spare pail..... | 0.781 | 1.019 | 0.238 | 0 | |
| Carry and attach milker..... | 1.019 | 1.451 | 0.432 | 9' | Dist. is av. |
| Change cow in stall..... | 1.451 | 1.724 | 0.273 | - | Change by 3's. Figs. here are 1/3 of ea. change charged to each cow. |
| Walk and feed cow.. | 1.724 | 1.991 | 0.267 | 7' | Dist. is av. Cows fed by 3's. Figs. here are 1/3 of ea. group charged to each cow |
| Carry spare pail of milk to surface cooler..... | 1.991 | 2.141 | 0.150 | 34' | Dist. is av. |
| Dump pail of milk into surface cooler strainer.... | 2.141 | 2.312 | 0.171 | 0 | |
| Carry spare pail to stall..... | 2.312 | 2.442 | 0.13 | 28' | Dist. is av. |

Total job group time = 2.442 minutes.

The 6-stall abreast parlor (Fig. 13, Table 17 and 17-a) is the basic plan used by most dairymen who use a milking parlor, either new or remodeled from a part of a stanchion barn. The cows are usually changed by groups. The dairyman must walk between every other pair of cows to feed.

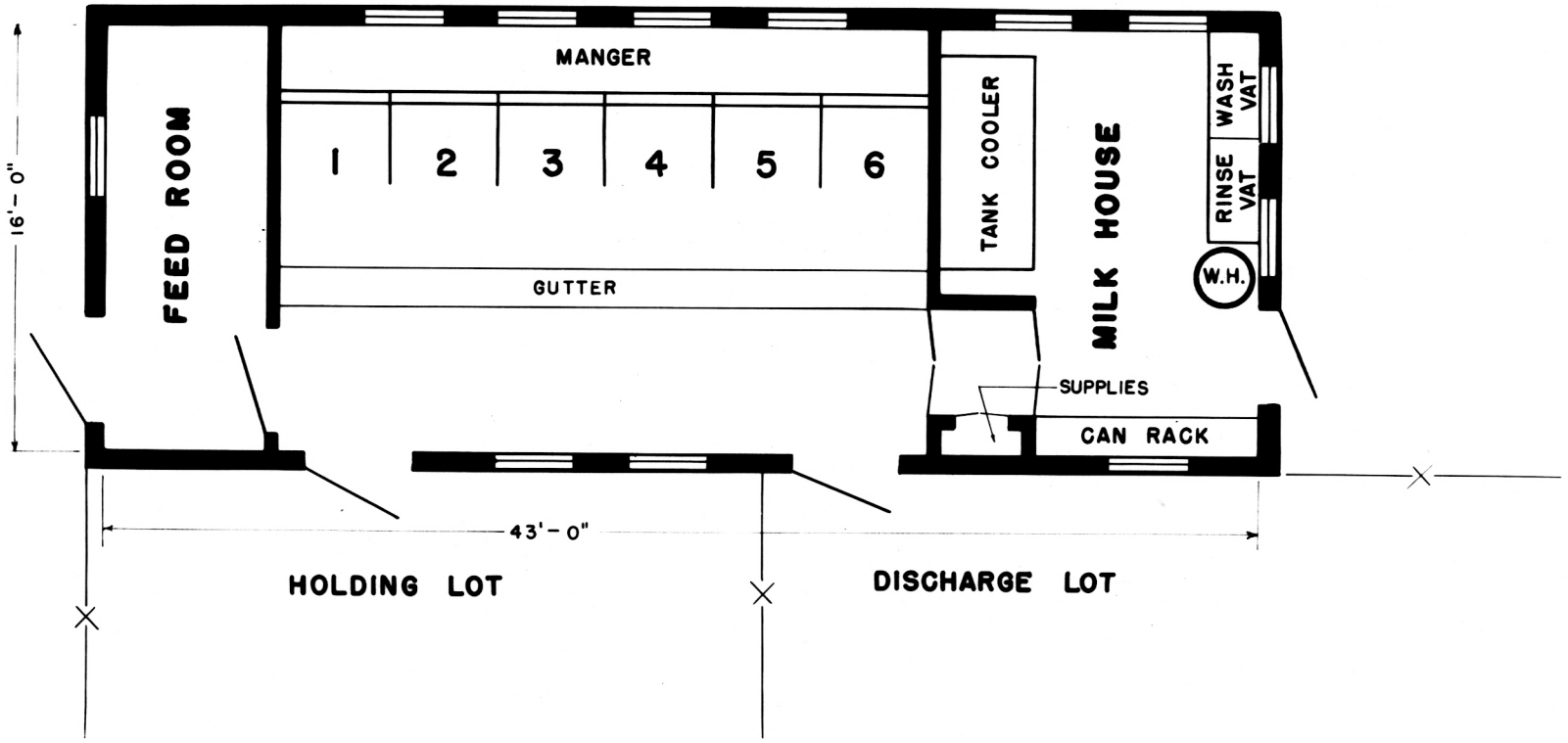



Fig. 13. 6-stall abreast milking parlor.

Table 17. Time routine for 6-stall abreast parlor (Fig. 13) using 2 bucket milkers with a spare pail and cows entering voluntarily by groups of 3.

| Work done | Dist. | Time | | | Milker location at end of work | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Start | End | Elapsed | A | B | |
| Open cow door and let 6 cows in stalls..... | 110' (cow) | 0.0 | 0.94 | 0.94 | Milk house | Milk house | Cannot take pails or mlkrs. to parlor or they get in the way |
| Walk and latch cows. | 53' | 0.94 | 1.374 | 0.434 | " | " | |
| Walk to feed room... | 12' | 1.374 | 1.444 | 0.07 | " | " | |
| Fill large pail with 30# grain..... | 0 | 1.444 | 1.594 | 0.15 | " | " | |
| Walk and feed 6 cows grain..... | 58' | 1.594 | 1.862 | 0.268 | " | " | |
| Walk to get udder wash and teat cup rinse pails..... | 21' | 1.862 | 1.966 | 0.104 | " | " | Need total of 2 udder wash and 4 teat cup rinse pails |
| Carry 6 pails to faucet on wall in center of cow alley. | 28' | 1.966 | 2.096 | 0.13 | " | " | |
| Run 6 pails of water, add chlorine powder, and distribute pails | - | 2.096 | 4.496 | 2.40 | " | " | Add powder and distribute pails while running water |

Table 17. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| Walk to get milkers and spare pail..... | 22' | 4.496 | 4.602 | 0.106 | Milk house | Milk house | |
| Carry milkers and pail to rear of stalls..... | 20' | 4.602 | 4.712 | 0.11 | Stall 5 | Stall 5 | |
| Walk and wash udder for milker A..... | 15' | 4.712 | 5.035 | 0.323 | " | " | |
| Attach milker A..... | 0 | 5.70 | 6.07 | 0.37 | Stall 6 | " | Machine strip[1] about 9.770 |
| Walk and wash udder for milker B..... | 15' | 7.2 | 7.523 | 0.323 | " | " | |
| Attach milker B..... | 0 | 8.176 | 8.546 | 0.37 | " | Stall 4 | Machine strip[1] about 12.246 |
| "A" job group (see table 17-a)..... | - | 9.485 | 11.944 | 2.459 | Stall 5 | " | Machine strip[1] about 14.723 |
| ...First cycle | | | | | | | |
| "B" job group..... | - | 11.961 | 14.420 | 2.459 | " | Stall 3 | Machine strip[1] about 17.199 |

[1]Had to use 3.7 min. between attach and machine strip.

Table 17. (concl.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| "A" job group.....) | - | 14.438 | 16.897 | 2.459 | Stall 6 | Stall 3 | |
| ...Second cycle | | | | | | | |
| "B" job group.....) | - | 16.914 | 19.373 | 2.459 | " | Stall 1 | |

These cycles continue until 30 cows are milked.

Summary

Cycle time = 4.953 mins. for 2 cows milked, of which .035 is waiting.
= 2.476 mins. per cow or 24.23 cows per man hour.
Total time for 30 cycles = 74.28 mins.
Starting time = 9.485 mins. (start to beginning of cycles).
Time to clean parlor = 6.680 mins. (384 sq. ft. at .0174 min./sq. ft.).
Total = 90.495 mins.
= 3.014 mins. per cow.
= 19.9 cows per man hour.

Table 17-a. Job group for 6-stall abreast parlor (Fig. 13). Job group repeated for every cow. Cows enter voluntarily in groups of 3.

| Work element | Time Start | Time End | Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|
| Wash udder..... | 0.0 | 0.285 | 0.285 | 10' | Dist. is av. |
| Walk and machine strip..... | 0.285 | 0.855 | 0.570 | 12' | Dist. is av. |
| Detach milker, dip teat cups, and transfer head to spare pail..... | 0.855 | 1.093 | 0.238 | 0 | |
| Carry and attach milker..... | 1.093 | 1.538 | 0.445 | 12' | Dist. is av. |
| Change cow in stall..... | 1.538 | 1.876 | 0.338 | - | Change by 3's. Figs. are for 1/3 of ea. change charged to each cow |
| Walk to get feed... | 1.876 | 1.911 | 0.035 | 7' | Dists. av. |
| Fill pail with 15# feed..... | 1.911 | 1.950 | 0.039 | 0 | Fed by 3's so take only 1/3 of time for ea. cow |
| Walk and feed cow grain..... | 1.950 | 2.032 | 0.082 | 15' | |
| Carry spare pail of milk to milk house. | 2.032 | 2.152 | 0.120 | 24' | Dist. is av. |
| Dump pail of milk into strainer and can..... | 2.152 | 2.323 | 0.171 | 0 | |
| Carry spare pail to stall..... | 2.323 | 2.459 | 0.136 | 30' | Dist. is av. |

Total job group time = 2.459 minutes.

The stanchion barn as shown (Fig. 14, Table 18, and Table 18-a) is the standard method of housing dairy cows in this country. The cows are milked in the barn and may remain there nearly constantly during the winter. In summer the herd is driven in the barn, fed, milked, and released. Most ordnances require that the milk not be poured in the milking barn; this requires carrying each milker of milk to the milk house.

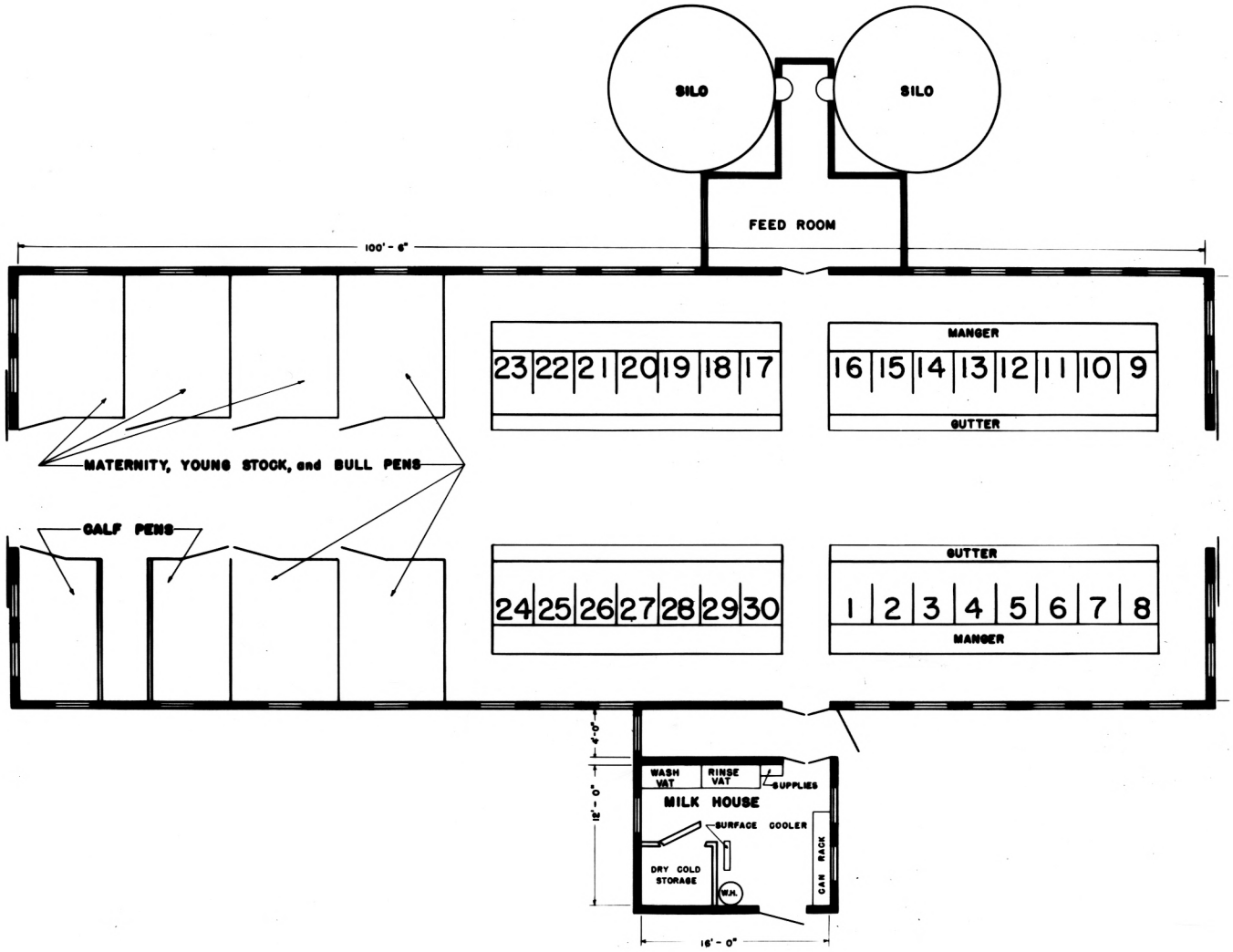



Fig. 14. 30-cow stanchion barn.

Table 18. Time routine for 30-cow stanchion barn (Fig. 14) using 2 bucket milkers and a spare milker pail.

| Work done | Dist. | Time | | | Milker location at end of work | | Remarks |
|---|---|---|---|---|---|---|---|
| | | Start | End | Elapsed | A | B | |
| Drive 30 cows into stalls..... | 204' | 0.0 | 1.87 | 1.87 | Milk house | Milk house | Assume each cow goes to stall readily |
| Walk and latch 30 cows..... | 165' | 1.87 | 4.09 | 2.22 | " | " | |
| Walk to get concentrates..... | 38' | 4.09 | 4.244 | 0.154 | " | " | |
| Fill cart with 150#. | 0 | 4.244 | 6.864 | 2.62 | " | " | |
| Feed cows grain from cart..... | 200' | 6.864 | 14.784 | 7.92 | " | " | |
| Walk to get udder wash and teat cup rinse pails..... | 53' | 14.784 | 14.978 | 0.194 | " | " | Use total of 1 udder wash and 2 teat cup rinse pails. These moved along with mlkrs. by dolly or rack. Add chlorine while water being run. |
| Run 3 pails water for udder wash and teat cup rinse..... | 0 | 14.978 | 16.178 | 1.20 | " | " | |
| Carry 3 pails water to rear of stall.... | 35' | 16.178 | 16.340 | 0.162 | " | " | |

Table 18. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| Wash udder for milker A..... | 10' | 16.340 | 16.625 | 0.285 | Milk house | Milk house | |
| Walk to get milkers and spare pail..... | 35' | 16.25 | 16.770 | 0.145 | " | " | |
| Carry milkers and spare pail to rear of stall 1..... | 35' | 16.770 | 16.930 | 0.160 | Behind stall 1 | Behind stall 1 | |
| Attach milker A..... | 0 | 17.340 | 17.710 | 0.37 | Stall 1 | Behind stall 1 | Machine strip about 21.21 |
| Walk and wash udder for milker B..... | 17' | 18.694 | 19.013 | 0.319 | " | Behind stall 3 | |
| Attach milker B..... | 0 | 19.694 | 20.064 | 0.37 | " | Stall 3 | Machine strip about 23.564 |
| "A" job group (see Table 18-a)..... | - | 20.925 | 22.959 | 2.034 | Stall 2 | " | Machine strip about 25.918 |
| ...First cycle | | | | | | | |
| "B" job group..... | - | 23.279 | 25.313 | 2.034 | " | Stall 4 | Machine strip about 28.272 |

Table 18. (concl.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | Milker location at end of work: B | Remarks |
|---|---|---|---|---|---|---|---|
| "A" job group.....) | - | 25.633 | 27.667 | 2.034 | Stall 5 | Stall 4 | |
| )...Second cycle | | | | | | | |
| "B" job group.....) | - | 27.987 | 30.021 | 2.034 | " | " | |

These cycles continue until 30 cows are milked.

Summary

Cycle time = 4.708 min. for 2 cows milked, of which 0.64 min. is waiting.
= 2.35 min. per cow or 25.5 cows per man hour.
= 76.5 min. for 30 cows.
Starting time = 20.925 min. (from start to beginning of cycles).
Time to clean barn = 26.80 min. (1,540 sq. ft. at .0174 min./sq. ft.).
Total = 124.221 min. for 30 cows.
= 4.14 min. per cow or 14.5 cows per man hour.

Table 18-a. Job group for 30-stall stanchion barn (Fig. 14). Job group repeated for every cow.

| Work element | Time | | | Dist. | Remarks |
|---|---|---|---|---|---|
| | Start | End | Elapsed | | |
| Wash udder..... | 0.00 | 0.285 | 0.285 | 10' | At stall where milkr. goes next |
| Walk and machine strip..... | 0.285 | 0.833 | 0.548 | 7' | Dist. is av. |
| Detach mlkr., dip teat cups, and transfer head to spare pail..... | 0.833 | 1.071 | 0.238 | 0 | |
| Carry and attach milker..... | 1.071 | 1.493 | 0.422 | 7' | Dist. is av. |
| Carry spare pail of milk to surface cooler..... | 1.493 | 1.685 | 0.192 | 47' | Dist. is av. |
| Dump pail of milk into surface cooler strainer..... | 1.685 | 1.856 | 0.171 | 0 | |
| Carry spare pail to stall..... | 1.856 | 2.034 | 0.178 | 47' | Dist. is av. |

Total time for job group = 2.034 minutes.

All of the above time calculations of milking in the various parlors were made on the basis that the cows enter the barn voluntarily. There are two types of parlors with respect to cow entry: (a) tandem, where only one cow may enter at a time, and (b) all others, where cows may enter by groups. Very little difference was found in milking cycle time for bringing in the cows in groups as compared to bringing them in singly when they

entered voluntarily (for a given parlor). This calculation applied, of course, only to class (b) parlors since cows in class (a) parlors can be changed singly only.

Another question remained. What happens to the routine if the operator has to go out into the holding lot to get the cows? This question was answered by making up a new routine for a representative parlor of each class (a and b) in which the operator was required to go to the holding lot for the cows. The 3-stall tandem parlor and the 6-stall Montana were selected for this calculation. By the same process used for the other routines, it was found that very little difference in cycle time and in total cows per man hour existed between the two methods (cows entering voluntarily vs. driving). However, for the 3-stall tandem parlor, a 3.6 minute period between attach milker and machine strip was necessary and this resulted in only 0.015 minutes of waiting per cycle when cows had to be driven in. When they entered voluntarily the corresponding times were 3.5 and .451 minutes, respectively. For the 6-stall Montana practically no change in any value existed. Table 19 is a summary of time routines for the various barns.

Table 19. Summary of values obtained from Tables 12 to 20-a.

| Type parlor | Cycle time per cow | Waiting time per cow during cycle | Total cycle time for 30 cows | Starting time | Time to fill feed storage boxes | Time to clean barn[1] | Total milking time for 30-cow herd | Cows per hour (Cycle time only) As computed | Cows per hour (Cycle time only) If each cow eats 5# grain | Grain cows eat in cycle as computed | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3-stall tandem | 2.378 | 0.225 | 71.4 | 9.647 | 3.865 | 5.60 | 90.512 | 25.2 | 16.70 | 2.4 | Ea. cow needs 10.5 min. in stall to eat 5# grain |
| 5-stall tandem | 2.378 | 0.122 | 71.4 | 10.547 | 5.147 | 8.23 | 95.324 | 25.2 | 25.2 | 5.2 | |
| 4-stall Montana | 2.304 | 0.117 | 69.1 | 8.947 | 3.655 | 5.61 | 87.312 | 26.0 | 22.2 | 4.0 | |
| 6-stall Montana | 2.393 | 0.087 | 75.2 | 12.147 | 4.502 | 8.091 | 99.94 | 25.1 | 25.1 | 7.6 | |
| 6-stall walk-through | 2.464 | 0.022 | 74.0 | 11.247 | 4.604 | 9.10 | 96.154 | 24.3 | 24.3 | 7.6 | 3.7 mins. between attach and mach. strip instead of 3.5 |
| 6-stall abreast | 2.476 | 0.017 | 74.28 | 9.485 | Not used | 6.680 | 90.445 | 24.23 | 24.23 | 7.7 | 3.7 min. between attach and mach. strip |
| 30-cow stanchion barn | 2.35 | 0.32 | 76.5 | 20.925 | Not used | 26.80 | 124.221 | 25.5 | 25.5 | - | Time of feeding incl. in starting time |
| 6-stall Montana with 3 unit combine mlkr. | 1.735 | 0.005 | 52.0 | 12.934 | 4.502 | 8.091 | 77.527 | 34.6 | 33.3 | 4.65 | 4.2 mins. between attach and mach. strip |

[1]During winter months, the parlors and stanchion barn were assumed to be cleaned by scraping, sweeping, shoveling manure, and liming. In addition, the stall portion of the stanchion barn was assumed to be bedded daily. If heat is available, the parlors can be cleaned by the same method as is used in the summer (hosing and sweeping). Following are the cleaning times in winter for each barn when no heat is available for the parlors:

| Type Parlor | Time to Clean in Winter |
|---|---|
| 3-stall tandem | 21.6 |
| 5-stall tandem | 31.7 |
| 4-stall Montana | 21.7 |
| 6-stall Montana | 31.2 |
| 6-stall walk-through | 35.0 |
| 6-stall abreast | 25.7 |
| 30-cow stanchion barn | 91.87 |

## Equipment

Bucket vs. Combine Milker. The 6-stall Montana parlor was used to compare the labor requirements of the combine milker with the bucket milker. Much interest is being shown in the combine milker, but they are expensive and this cost has to be justified by labor saved. A combine milker is one in which the milk goes into a sanitary pipe instead of a milker pail. With the sanitary pipe, the milk is carried from the milking barn to the milkhouse where it is released into milk cans or directly to a surface cooler. The dairyman thus needs to go into the milkhouse infrequently during milking to change three or four cans on the can fillers or under the surface cooler. Plate II shows a combine milker used in a tandem parlor. Only one parlor, the 6-stall Montana, was used for which to calculate the routine for a combine milker. The other plans of 6-stall would be very similar, but for the plans using only 3 or 4 stalls, very little would be gained by using the combine milker instead of the bucket milkers. Tables 20 and 20-a show the time routine for the 6-stall Montana parlor when used with a 3-unit combine milker. A summary of this table is also tabulated in Table 19.

## EXPLANATION OF PLATE II

A tandem parlor in which a combine milker was used. The dairyman here actually did not use the milker as a true combine in that he released the milk into 10-gallon milk cans placed near each weighing jar shown here. The cans were then taken into the milkhouse and dumped. Concentrates were stored in the barrels. Washing stalls outside the picture to the left were not used because the operator found he could milk more cows per hour if he washed the udders in the milking stalls instead of making two moves. This parlor was much larger than necessary, had no pit for the operator, and had an unnecessary gutter.

PLATE II

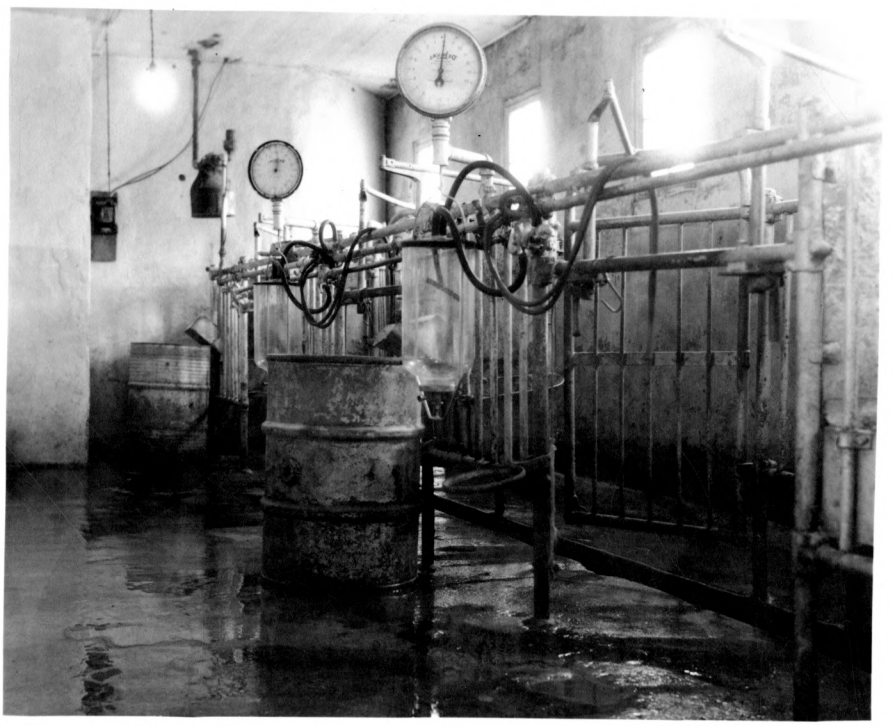


Table 20. Time routine for 6-stall Montana parlor (Fig. 11) using 3 combine milker units and cows entering singly voluntarily.

| Work done | Dist. | Time Start | Time End | Time Elapsed | Milker location at end of work A | B | C | Remarks |
|---|---|---|---|---|---|---|---|---|
| Carry milker units to parlor and attach to pipe lines..... | 76' | 0.0 | 0.479 | 0.479 | Stalls 2 & 3 | Stalls 4 & 5 | Stall 1 | Use 1 mlkr. between stalls 2 & 3, 1 between 4 & 5 & move 1 between 1&6 |
| Open cow doors and let 6 cows in stalls | 62' (cow) | 0.479 | 1.039 | 0.560 | " | " | " | |
| Walk to each stall, feed and latch cows. | 50' | 1.039 | 2.869 | 1.830 | " | " | " | Need 1 udder wash and 2 teat cup rinse pails |
| Carry 12 pails to center of pit..... | 23' | 2.962 | 3.078 | 0.116 | " | " | " | ---at ea. mlkr. position. Faucet near center of pit |
| Run 12 pails of water, add chlorine powder, and distribute pails | - | 3.078 | 7.878 | 4.80 | " | " | " | Add chlorine and distri- ---bute pails while water being run |
| Wash udder for milker A..... | - | 7.878 | 8.248 | 0.223 | " | " | " | |
| Attach milker A..... | - | 8.878 | 9.068 | 0.190 | Stall 2 | " | " | Machine strip[1] about 13.269 |

Table 20. (cont.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | B | C | Remarks |
|---|---|---|---|---|---|---|---|---|
| Walk and wash udder for milker B..... | - | 9.613 | 9.948 | 0.335 | Stall 2 | Stalls 4 & 5 | Stall 1 | |
| Attach milker B..... | - | 10.613 | 10.804 | 0.191 | " | Stall 4 | " | Machine strip[1] about 15.004 |
| Walk and wash udder for milker C..... | - | 11.348 | 11.683 | 0.335 | " | " | " | |
| Attach milker C..... | - | 12.348 | 12.539 | 0.191 | " | " | " | Machine strip[1] about 16.739 |
| "A" job group (see Table 19-a)..... | - | 12.934 | 14.664 | - | Stall 3 | " | " | Machine strip[1] about 18.474 |
| "B" job group..... | - | 14.669 | 16.399 | - | " | Stall 5 | " | Machine strip[1] about 20.209 |
| "C" job group..... | - | 16.404 | 18.134 | - | " | " | Stall 6 | Machine strip[1] about 21.944 |

...First cycle

Table 20. (concl.).

| Work done | Dist. | Time: Start | Time: End | Time: Elapsed | Milker location at end of work: A | B | C | Remarks |
|---|---|---|---|---|---|---|---|---|
| "A" job group.....) | - | 18.139 | 19.869 | - | Stall 2 | Stall 5 | Stall 6 | |
| ...Second cycle | | | | | | | | |
| "B" job group.....) | - | 19.874 | 21.604 | | | | | |
| "C" job group.....) | - | 21.609 | 23.339 | | | | | |

These cycles continue until 30 cows are milked.
Time to fill feed storage boxes = 4.502 minutes.

Summary

Cycle time = 5.205 min. for 3 cows milked, of which .015 is waiting.
= 1.735 min. per cow or 34.6 cows per man hour.
= 52.0 min. for 30 cows.
Starting time = 12.934 min. (from start to beginning of cycles).
Time to clean parlor = 8.091 min. (465 sq. ft. at .0174 min./sq. ft.).
Time to fill feed boxes = 4.502 min.
Total = 77.527 for 30 cows = 2.584 min. per cow.
= 23.21 cows per man hour.

[1]Had to use 4.2 minutes between attach milker and machine strip.

Table 20-a. Job group for 6-stall Montana parlor (Fig. 11) when using 3 combine milker units. Job group repeated for every cow. Cows enter singly voluntarily.

| Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|
| Walk and wash udder | 0.0 | 0.335 | 0.335 | 24' | Dist. is av. |
| Walk and machine strip..... | 0.335 | 0.887 | 0.552 | 8' | Dist. is av. |
| Detach milker and dip teat cups..... | - | 1.033 | 0.146 | 0 | |
| Carry and attach milker..... | - | 1.340 | 0.307 | 8' | Dist. is av. |
| Change cow in stall and feed cow grain..... | - | 1.730 | 0.39 | - | Dist. is av. Cow fed while changing |

Total job group time = 1.730 minutes.

As shown in Table 19, it was necessary to use a period of 4.2 minutes between attaching milker and machine stripping. Nevertheless, the number of cows per man hour was very high compared to the cases where two bucket milkers were used. The use of only two units on a combine milker is obviously of no advantage over the use of two bucket milkers where a total machine time of 4.0 minutes for each cow is used.

## Work Methods

Flush vs. Brush Washing of Milkers. As was described in the Review of Literature, flush washing of milkers appears to have no objections in terms of producing sanitary milk. Combine milkers are out of the question for all but the very large

dairys if the entire system must be disassembled for washing every milking or even every day. However, flush washing and brush washing were compared for both combine and bucket milkers. Table 21 shows the comparison of these two methods of milker washing for both combine and bucket milkers on a per unit basis. Brush washing requires complete disassembly of milker.

Table 21. Time required for flush washing compared to brush washing of combine and bucket milkers.

| Brush Washing | | | |
|---|---|---|---|
| Combine milker | | Bucket milker | |
| Work element | Time (min.) | Work element | Time (min.) |
| Disassemble, wash, rinse, and reassemble combine milker with 44' of sanitary pipe, line filter, 3 can fillers, 3 units, and can filler header. (This fig. was obtained from one dairyman who timed himself several times). | 90.0 | Disassemble milker | 0.7 |
| | | Wash teat cups and inflations | 0.91 |
| | | Rinse teat cups and inflations | 0.014 |
| | | Wash milker bowl | 0.54 |
| | | Rinse milker bowl | 0.22 |
| | | Wash milker head | 0.33 |
| | | Rinse milker head | 0.22 |
| | | Assemble milker | 1.22 |
| Totals | 90.0 | | 4.024 |
| Time per unit | 30.0 | | 4.024 |

| Flush washing | | | |
|---|---|---|---|
| Combine milker | | Bucket milker | |
| Take cans of milk off fillers and put on empties | 1.22 | Fill a pail with warm water and add detergent | 0.4 |
| Draw 3 pails warm water and add wetting agent | 1.20 | Rinse milker with detergent water by sucking water through teat cups and shaking milker | 0.51 |
| Carry 3 pails warm detergent water to parlor and distribute to milkers | 0.374 | Dump water and replace head | 0.2 |
| Rinse milker by letting vacuum draw warm detergent water through | 0.90 | Fill a pail with hot water | 0.4 |
| Walk to wash vat to get hot water | 0.108 | | |

Table 21. (concl.).

| Flush washing | | | |
|---|---|---|---|
| Combine milker | | Bucket milker | |
| Work element | Time (min.) | Work element | Time (min.) |
| Carry 3 pails hot water to parlor and distribute | 0.374 | Rinse milker with hot water | 0.51 |
| Rinse milker with hot water | 0.90 | Dump water and hang up to dry | 0.2 |
| Detach units and carry to milkhouse | 0.566 | Before next milking | |
| Detach cows and dump water | 0.92 | Fill a pail with cold water and add chlorine powder | 0.4 |
| Before next milking | | Rinse milker with cold chlorine water | 0.51 |
| Draw 3 pails cold water and add chlorine powder | 1.20 | Dump water and replace head | 0.20 |
| Carry 3 pails cold chlorine water to parlor and distribute | 0.374 | | |
| Rinse milker with cold chlorine water | 0.90 | | |
| Walk to can fillers | 0.10 | | |
| Detach cans, dump water, and replace cans | 1.22 | | |
| Open filter housing and insert filter | 1.98 | | |
| Totals | 12.336 | | 3.33 |
| Time per unit | 4.112 | | 3.33 |
| Total milker washing time: | | | |
| Combine milker (3 units) | 90.0 by brush; 12.336 by flush | | |
| Bucket milker (2 units) | 8.048 by brush; 6.66 by flush | | |

## Hay and Silage Feeding

Silage Feeding. Comparisons of four methods of feeding silage were made. These methods were (a) pitch silage from silo to wagon and haul to bunk, (b) pitch silage to ground and carry to bunk in a basket, (c) pitch silage to cart and distribute with the cart on top of bunk, and (d) use silo unloader to move silage to cart and then distribute silage from cart. Figure 15 illustrates four methods of feeding silage. It was assumed that each of the 30 cows required 30 pounds per day or a total of 900 pounds of silage to be fed daily. Table 22 shows the calculation of time required by the dairyman for each method of feeding.

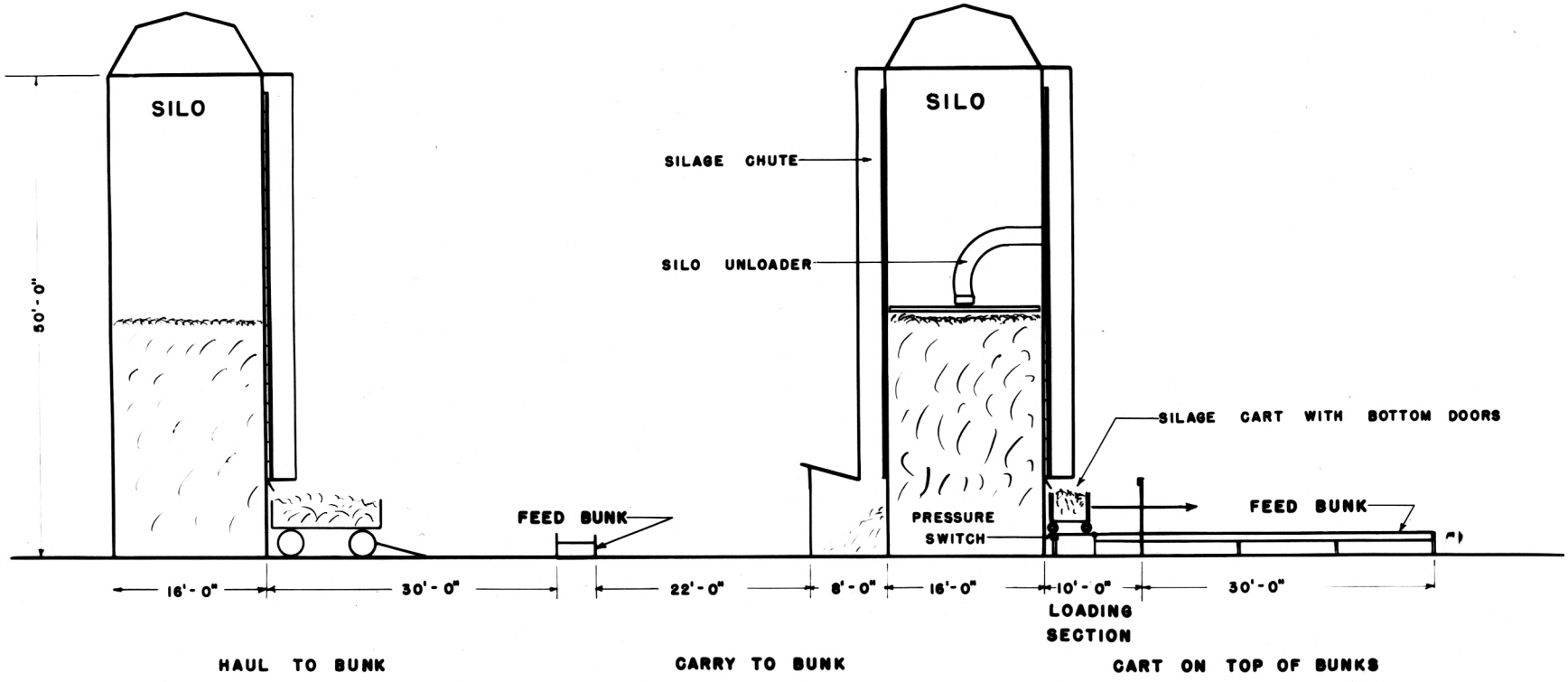



Fig. 15. Four methods of feeding silage.

Table 22. Time requirements for feeding silage by four methods (Fig. 15).

| Method of feeding | Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|---|
| (a) Pitch silage into wagon and haul to bunk | Get tractor out of shed | 0.0 | 0.830 | 0.830 | 0 | |
| | Drive tractor to silo | 0.830 | 1.127 | 0.297 | 100' | Dist. is assumed |
| Total time: 19.418 min. per day | Hitch tractor to trailer | 1.127 | 1.737 | 0.61 | 0 | |
| | Climb into silo | 1.737 | 2.229 | 0.492 | 25' | Dist. is average |
| | Pitch 900# silage into trailer | 2.229 | 9.564 | 7.335 | 0 | |
| | Climb from silo | 9.564 | 10.056 | 0.492 | 25' | Dist. is average |
| | Move trailer to bunk nearby | 10.056 | 10.616 | 0.56 | 30' | |
| | Pitch silage from trailer to bunk | 10.616 | 17.951 | 7.335 | 0 | |
| | Move trailer back under silo chute | 17.951 | 18.511 | 0.56 | 30' | |
| | Unhitch trailer | 18.511 | 19.121 | 0.61 | 0 | |
| (b) Pitch silage to ground and carry to bunk in a basket | Climb into silo | 0.0 | 0.492 | 0.492 | 25' | Dist. is average |
| | Pitch 900# silage to ground | 0.492 | 7.827 | 7.335 | 0 | |
| Total time: 20.589 min. per day | | | | | | |

Table 22. (concl.).

| Method of feeding | Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|---|
| | Climb from silo | 7.827 | 8.319 | 0.492 | 25' | Dist. is average |
| | Carry 900# silage 30' to bunk in basket at 50# per trip | 8.319 | 20.589 | 12.27 | 1080' | |
| (c) Pitch silage into cart and distribute by rolling cart on top of bunks | Climb into silo | 0.0 | 0.492 | 0.492 | 25' | Dist. is average |
| | Pitch 900# silage into cart | 0.492 | 7.827 | 7.335 | 0 | |
| Total time: 14.259 min. per day | Climb from silo | 7.827 | 8.319 | 0.492 | 25' | Dist. is average |
| | Distribute 900# silage in bunk from cart | 8.319 | 14.259 | 5.94 | 80' | Cart should have bottom doors |
| (d) Use silo unloader to fill cart and then distribute silage by rolling car on top of bunks | Walk to and from silo to turn on unloader switch | 0.0 | 0.68 | 0.68 | 200' | Dist. is assumed Cart should have bottom doors |
| | Distribute 900# silage in bunk from cart | 0.68 | 6.620 | 5.94 | 80' | |
| Total time: 9.620 min. per day | Move unloader duct | 6.620 | 9.620 | 3.0 | - | Time is est. portion charged to each day |

Hay Feeding. Five methods of feeding hay were compared: (a) pitch hay to ground and carry to manger in lot, (b) pitch hay

to wagon and haul to manger in lot, (c) use fixed manger alongside hay in barn and carry hay from mow directly to manger, (d) use traveling manger and move it up to hay face, (e) fill large, covered hay feeding rack infrequently with a fork and carrier from the mow. These methods are illustrated in Fig. 16. Three of these methods (a, b, and c) are commonly used. Method (d) has been used a few times, but method (e) is a proposed method. This last method requires an electric winch and a control that can be operated from mow. It was assumed that each cow needs 15 pounds of hay per day or a total of 450 pounds for the 30-cow herd. Table 23 shows the calculation of time required by the dairyman for each method. Loose hay was used in all computations since it represents the form most commonly used for feeding. Baled and chopped hay would give nearly the same ratio of results between methods and chopped hay would probably require a special bucket in method (e). Neither chopped nor baled hay would require cutting down with a hay knife.

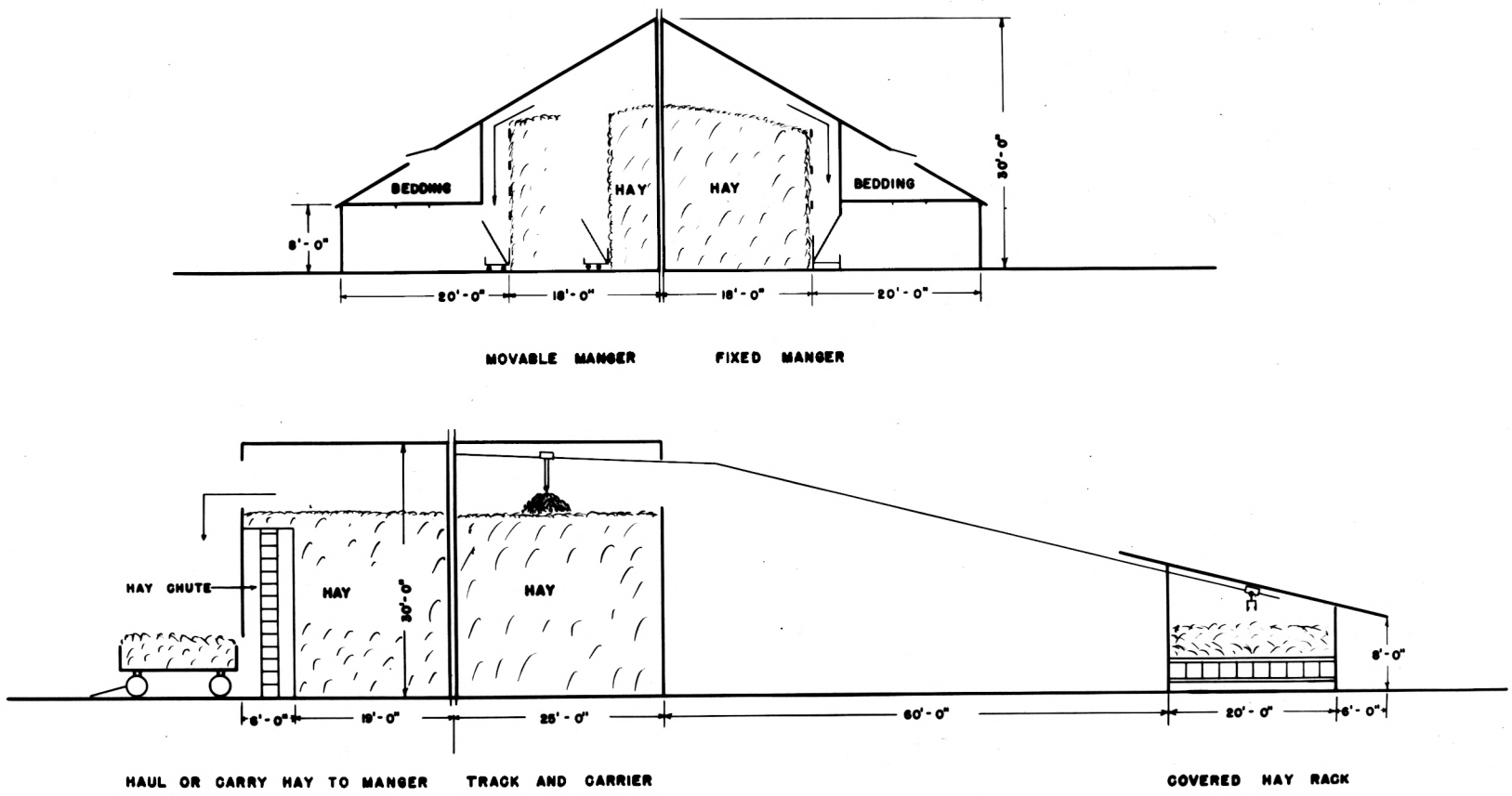



Fig. 16. Five methods of feeding hay.

Table 23. Time requirements for feeding hay by four methods (Fig. 16).

| Method of feeding | Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|---|
| (a) Pitch hay to ground and carry to manger in lot<br><br>Total time: 27.544 min. per day | Climb into mow | 0.0 | 0.197 | 0.197 | 10' | Dist. is average |
| | Walk 25' to center of barn 31 times | 0.197 | 3.757 | 3.56 | 775' | Dist. is average |
| | Pitch 31 forks of hay at 14.3# per fork = 450# | 3.757 | 7.167 | 3.41 | 0 | |
| | Carry 14.3# hay from center of barn to chute or window 31 times | 7.167 | 10.887 | 3.72 | 525' | Dist. is average |
| | Cut down hay for next feeding | 10.887 | 19.167 | 8.28 | 0 | |
| | Climb from mow | 19.167 | 19.364 | 0.197 | 10' | Dist. is average |
| | Carry 14.3# hay from chute 30' to manger in lot 31 times | 19.364 | 23.514 | 4.15 | 930' | |
| | Walk back 30' from manger to chute 31 times | 23.514 | 27.544 | 4.03 | 930' | |

Table 23. (cont.).

| Method of feeding | Work element | Time: Start | Time: End | Time: Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|---|
| (b) Pitch hay to wagon and haul to manger in lot<br><br>Total time: 29.108 min. per day | Get tractor out of shed | 0.0 | 0.830 | 0.830 | 0 | |
| | Drive tractor to barn | 0.830 | 1.127 | 0.297 | 100' | Dist. is average |
| | Hitch tractor to trailer | 1.127 | 1.737 | 0.61 | 0 | |
| | Climb into mow | 1.737 | 1.934 | 0.197 | 10' | Dist. is average |
| | Walk 25' to center of barn 31 times | 1.934 | 5.494 | 3.56 | 775' | Dist. is average |
| | Pitch 31 forks of hay at 14.3# per fork = 300# | 5.494 | 8.904 | 3.41 | 0 | |
| | Carry 14.3# hay from center of barn to chute or window 31 times | 8.904 | 12.624 | 3.72 | 775' | Dist. is average |
| | Cut down hay for next feeding | 12.624 | 20.904 | 8.28 | 0 | |
| | Climb from mow | 20.904 | 21.101 | 0.197 | 10' | Dist. is average |
| | Move trailer to manger nearby | 21.101 | 21.661 | 0.56 | 30' | |
| | Pitch hay from trailer to manger | 21.661 | 27.641 | 5.98 | 0 | |

Table 23. (cont.).

| Method of feeding | Work element | Time: Start | Time: End | Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|---|
| | Move trailer back to barn | 27.641 | 28.201 | 0.56 | 30' | |
| | Unhitch trailer | 28.201 | 28.811 | 0.61 | 0 | |
| | Drive tractor to shed | 28.811 | 29.108 | 0.297 | 100' | |
| (c) Fixed manger alongside hay in barn to which hay carried by fork | Climb into mow | 0.0 | 0.197 | 0.197 | 10' | Dist. is average |
| | Walk 18' to center of barn 31 times | 0.197 | 3.079 | 2.882 | 558' | Dist. is average |
| | Pitch 31 forks of hay at 14.3# per fork | 3.079 | 6.489 | 3.41 | 0 | |
| | Carry 14.3# hay 18' 31 times from center of barn to manger | 6.489 | 9.459 | 2.97 | 558' | Dist. is average |
| | Cut cown hay for next time | 9.459 | 17.739 | 8.28 | 0 | |
| | Climb from mow | 17.739 | 17.936 | 0.197 | 10' | Dist. is average |
| (d) Movable manger alongside hay in barn. Hay bench fed to floor and then manger moved up to new bench. | Climb into mow | 0.0 | 0.197 | 0.197 | 10' | Dist. is average |
| | Pitch 31 forks of hay at 8.2#/ fork into manger | 0.197 | 6.177 | 5.98 | 0 | |

Table 23. (concl.).

| Method of feeding | Work element | Time: Start | Time: End | Elapsed | Dist. | Remarks |
|---|---|---|---|---|---|---|
| Total time: 17.054 min. per day | Cut down hay for next time | 6.177 | 14.457 | 8.28 | 0 | |
| | Climb from mow | 14.457 | 14.654 | 0.197 | 10' | Dist. is average |
| | Move manger to next bench | 14.654 | 17.054 | 2.4 | - | Use a bench 5' wide, assume it requires 120 mins. to move the manger, and be done every 50 days |
| (e) Fill covered, large manger once a week with track and carrier<br><br>Time per day: 11.78 | Climb into mow | 0.00 | 0.197 | 0.197 | 10' | Dist. is average |
| | Move 16 loads of hay at 200# per load to covered manger. Assume 1.5 mins. per fork | 0.197 | 24.197 | 24.0 | - | This information was obtained by assuming reasonable rates for ea. part of oper. |
| | Cut down hay for a week's feeding | 24.197 | 82.157 | 57.96 | | |
| | Climb from mow | 82.157 | 82.354 | 0.197 | 10' | Dist. is average |

# DISCUSSIONS OF RESULTS AND CONCLUSIONS

## Milking Barns

Table 19 clearly shows the advantage the parlors have over the stanchion barn in terms of time to milk the herd. When two bucket milkers with an extra milker pail were used, very little difference was shown in the cycle time of the different milking parlors, mainly because the routine followed provided for rapid transfer of the milker from one cow to another without carrying the milker head to the milkhouse. When total milking time for a 30-cow herd is considered, the 3-stall tandem, 4-stall Montana, and 6-stall abreast parlors are a little more efficient than the others; and all parlors are considerably better than the stanchion barn. The above observations apply to the parlors only when the requirement is not made that the cows eat 5 pounds of grain while in the barn. When this requirement is made, the 3-stall tandem drops way down and the 4-stall Montana suffers a little. These calculations verify an observation made by many people that the cows cannot eat enough grain in the 3-stall parlors. The figure of 5 pounds of grain per milking is not considered excessive feeding in that many owners of high producing herds feed more than this amount at least for a few months when the milk flow is heavy. A parlor cannot be recommended which requires a low producing herd or other poor practices to make it work properly. The group feeding of some grain after milking is resorted to by some dairymen who find themselves with a parlor

having too few stalls, but this practice requires more time. Also, the dairyman has no assurance that each cow will get her share when group fed. It appears, therefore, that the use of at least a 5 or preferably a 6-stall parlor is highly desirable. Further increase of stall number gains nothing unless the cows are being fed very large amounts of grain. Table 24 shows total milking time for a 30-cow herd in each parlor when the requirement is made that each cow eat 5 pounds of grain.

Table 24. Total milking time (includes starting time, total cycle time, time to fill feed storage boxes, and time to clean barn) when each cow eats 5 pounds of concentrates.

| Parlor | Milkers used | Total milking time (min.) Summer | Winter and no heat |
|---|---|---|---|
| 3-stall tandem | 2 bucket and 1 spare pail | 127.112 | 143.112 |
| 5-stall tandem | " | 95.324 | 118.794 |
| 4-stall Montana | " | 99.212 | 115.302 |
| 6-stall Montana | " | 99.94 | 123.049 |
| 6-stall walk-through | " | 96.154 | 122.054 |
| 6-stall abreast | " | 90.445 | 109.465 |
| 30-stall stanchion | " | 124.221 | 189.291 |
| 6-stall Montana | 3-unit combine | 79.527 | 102.636 |

From table 24 it is readily apparent that the 3-stall tandem requires too much time if each cow must eat 5 pounds of grain.

Combine Milker. The use of a 3-unit combine milker increased

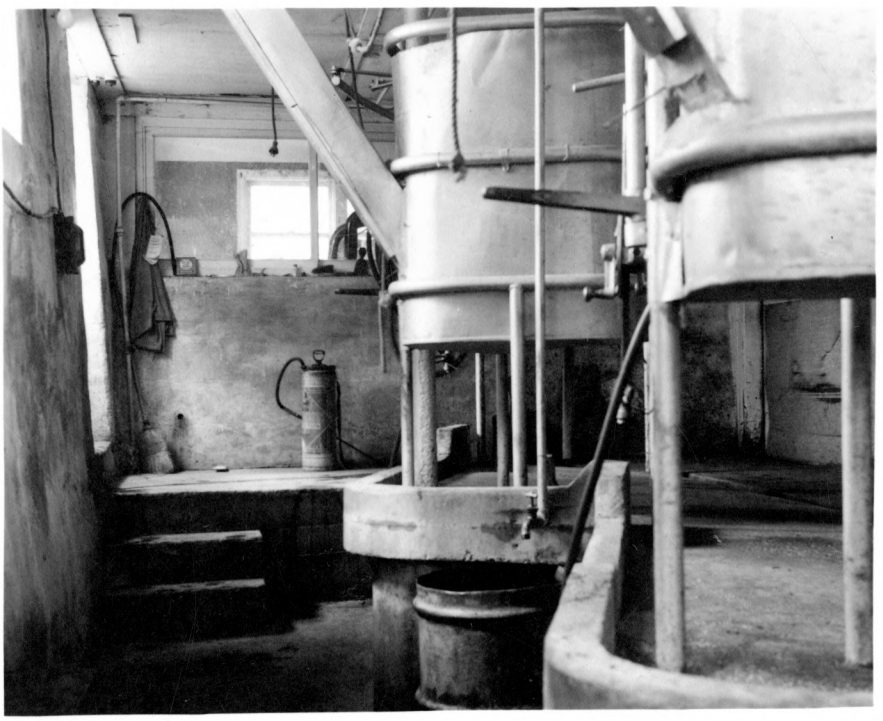
the cows milked per man hour considerably even though the machine time had to be increased a little. Where the herd is large and where milk ordnances permit flush washing of milkers, the combine milker with 3 units appears very desirable. However, a very large herd would be required before the gain in milking time would absorb the 90 minutes required to brush wash a combine milker. A net average gain of about 15 minutes per milking for a 30-cow herd could be had by the use of the combine milker when flush washed. Plate II shows a combine milker that included weighing jars.

Ease of Work. One factor that does not appear in the calculations in the tables above is the ease of using the elevated stall. The 6-stall walk-through, the 6-stall abreast, and the 30-cow stanchion barn do not have elevated stalls (Fig. 10). No apparent differences in time required to do the various jobs were observed for the elevated as compared to the regular stalls, but much less fatigue was reported by several users. They thought also that they did a better job of udder washing (resulting in cleaner milk) in the elevated stalls. Plate I shows the operator's side of some tandem elevated stalls and Plate III is the same view of a semi-tandem parlor. Feed was fed from overhead through the sloping chutes seen connected to the feed box. Shields around the feed box are especially desirable to avoid spilling grain. Plate II is a view of a tandem parlor without elevated stalls and with barrels near the milking stalls in which concentrates were stored.

## EXPLANATION OF PLATE III

A semi-tandem parlor in which the stalls are set at an angle instead of one stall directly in front of the other. A small gutter was used in this parlor which, as usual, caused the cows some difficulty in entering the stall, especially when their feet were muddy. Grain was fed from a small pile in an overhead bin through the slanting chute seen in the upper left part of the picture. Cows were let into the parlor from the pit by the operator pulling a rope.

PLATE III



Cow Entry into Parlor. While the calculations found no great loss in time for the tandem parlors when the operator had to herd the cows one at a time, the routine had less spare time. This indicates that the parlors such as walk-through and Montana have the advantage of being able to allow cows to come in singly voluntarily if they will and will not bog down if the dairyman has to drive the cows since he can get them in groups. The actual routine followed is by no means as rigid as those shown in the tables, and any irregularities are likely to waste time in a parlor where each cow must be driven in individually and on schedule. When cows are changed by groups, the dairyman can choose the time over a wider range than for changing singly.

Number of Milkers. The calculations show that only in the case of a combine unit can 3 milkers be used. When more units are used, the machine time simply rises in proportion so that no more cows per hour are milked and the dairyman then has another milker to wash and purchase. Two bucket milkers with the extra pail for carrying milk to the milkhouse was the best arrangement.

Milk House Chores. This work was constant for all barns except for washing the combine milker compared to the bucket milker which was presented in Table 21. Since the milkhouse work was the same for all barns, no comparisons or computations of total milkhouse chore time were made. On the average dairy farm where the milk is not bottled, the milkhouse chores are of rather short duration when the milkhouse is equipped properly with hot

and cold running water.

Cleaning Parlors. As noted in Table 8, the fastest method of cleaning is by hosing and sweeping. This can be done in the parlor even in cold weather if some artificial heat is provided. This provision should be made to allow the operator to work in comfort and to prevent freezing of water on the floor and in pipes.

## Flush Washing

Flush washing makes practicable the use of combine milkers on herds of 30 cows or more. Since results of bacteria counts indicate good cleaning by flush washing of bucket milkers, flush washing of bucket milkers could be recommended even though the time saved is not great.

## Hay and Silage Feeding

Silage Feeding. Table 25 summarizes the results of Table 22. The use of a cart on top of the bunks offers considerable gain in time by eliminating pitching a second time and/or carrying silage to the bunk by hand from the silo. The silo unloader is advantageous where an automatic shutoff switch is provided to turn off the unloader when a given amount of silage has been loaded into the cart. Unloaders are mostly rather slow and very little is gained where the dairyman must stand by and watch it.

Table 25. Time required for feeding 900 pounds of silage daily by various methods.

| Method of feeding | Total time required |
|---|---|
| (a) Pitch silage into trailer and haul to bunk | 19.418 mins. |
| (b) Pitch silage to ground and carry to bunk in basket | 20.589 " |
| (c) Pitch silage to cart on top of bunks and distribute from cart | 14.259 " |
| (d) Silo unloader to fill cart on top of bunks and distribute from cart | 9.620 " |

Hay Feeding. The results of Table 23 are summarized in Table 26 and are quite self explanatory. Certainly the mangers alongside the hay are to be recommended and the proposed method of weekly feeding by track and carrier warrants actual trial since the daily time requirements appear to be small. The movable manger scheme offers a reduction in building cost to the dairyman in that the cows get more and more shelter as the winter becomes more severe. The herd requires very little shelter in the fall when hay feeding begins. A narrow shed along the manger side of the hay barn or even just a lot with a windbreak would probably suffice until the herd had consumed enough hay to have adequate shelter in the barn. Many dairymen feed hay by one of the methods (a) or (b), and it is apparent why hay feeding is to them a big job. Feeding from a stack would compare to methods

(c) and (d) if a manger surrounded the stack, to method (a) if the hay were pitched off and carried, or to method (b) if the hay were pitched onto a trailer and hauled to manger or fed on the ground.

Table 26. Time required for feeding 450 pounds of hay daily by various methods.

| Method of feeding | Daily time to feed hay (minutes) |
|---|---|
| (a) Pitch to ground and carry to manger | 27.544 |
| (b) Pitch to wagon and haul to manger | 29.108 |
| (c) Fixed manger alongside hay | 17.936 |
| (d) Movable manger alongside hay | 17.054 |
| (e) Carrier and large manger | 11.780 |

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# APPENDIX

## A. Group Average Method of Plotting Curves

Since a great deal of variation occurred in the time spent doing dairy chores, no curve could have been drawn easily. The method of group averages provided a way to get representative values of ordinate for a given value of abscissa. This method consisted of arbitrarily dividing the abscissa into a number of intervals. Then within each one of these small intervals, the values of the ordinates whose abscissas fell within the given interval were averaged to give one point. This process was repeated for each interval after which a curve was drawn through the resulting points.

## B. Method of Calculating Best-Fit-Line

Line Does Not Pass Through Origin. Anytime a curve is drawn through a set of points, the question arises as to where the curve should be drawn. The first step is to plot the scatter diagram on graph paper to see what kind of curve in general will be permissable. Where it appears that a straight line could fit the data about as well as any curve, this is done since it is the simplest. Where the data obviously does not fit a straight line, higher order curves should be used if possible, or just draw an eye fitted curve through the points. The best-fit-line that does not go through the origin is:

$$Y = y + \frac{s(xy)}{s(x^2)} (X - x$$

where $Y$ = ordinate of best-fit-line at abscissa X
$y$ = arithmetic mean of Y of all points
$s(xy)$ = sum of products of deviations from means
$s(X^2)$ = sum of squares of deviations of X's from x
$Y$ = ordinate of each point
$X$ = abscissa of each point
$x$ = arithmetic mean of X of all points

The shortest calculation of s (xy) and $s(x^2)$ is given by

$$s(xy) = s(XY) - \frac{s(X)\ s(Y)}{n}$$

$$s(X^2) = s(X^2) - \frac{s(X)^2}{n}$$

where $s(XY)$ = sum of all products of each abscissa X times its ordinate Y
$s(X)$ = sum of X for all points
$s(Y)$ = sum of Y for all points
$n$ = number of points
$s(X^2)$ = sum of squares of all X
$s(X)^2$ = sum of all X's squared

Line Passes Through Origin. Many times it is known that the line must pass through the origin. An example of this may be given as plotting distance walked versus time to walk. Several points, not all the same, would be found if several people at varying distances were timed. Even though the best-fit-line as defined above does not pass through the origin, it can be safely said that the true line does go through X = 0, Y = 0 because a person cannot walk any distance in zero time. For this sort of case, the equation of the line is $Y = \frac{s(XY)}{sX^2} X$ where the symbols mean the same as above.