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What to Expect from the Herringbone Milking Parlor

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Labor efficiency for milking in parlors under average conditions can be described by three equations:

(i) Parlor cycle time (min.) = number of units x man minutes a cow

(ii) Output (cows/man hour) = $\dfrac{60}{n \times t - man}$

(iii) Unit time on cow (min.) = parlor cycle time + idle time

The all important factor is unit time on the cow. As might be expected by an engineer, the rate at which milk is drawn through an orifice of given size (a teat) depends upon:

the pressure difference across the orifice and

the time for which that pressure acts.

If these are unchanged then the time taken by the milking unit for ejection of a quantity of milk Q can be expressed in the form of a fourth equation:

$$t = a + bQ$$

In a study by Drs. Dodd and Clough (1) of the British National Institute of Research in Dairying found the constants to be:

$a = 1.6$ $\qquad\qquad\qquad\qquad$ $b = 0.16$

Where t is in minutes and Q in pounds. During his recent stay in the U. S. as Visiting Professor of Dairying at the University of Illinois Dr. Dodd found every indication that American cows did not differ significantly from their sisters found in England.

However, the vacuum applied and the portion of the milking machine cycle for which the vacuum was applied differed appreciably. The lower the vacuum the slower the rate of ejection; and the wider the pulsation ration of vacuum to release the faster the milk ejection. Ratios of up to 1 to 5 have proved satisfactory. Vacuums of over 20 inches have been used in some machines. Very high vacuum machines seem to require an increased time in machine stripping.

The milking time curve produced by Dodd and Clough (figure 1) shows that for a yield of 10 lb. the unit takes an average of 3.2 min., 15 lb. the unit takes an average of 4.0 min., and 20 lb. the unit takes an average of 4.8 min.

To this time requirement is added one minute for applying unit, stripping, and removing the unit; this gives unit times of 4.2 min for 10 lb, 5.0 min for 15 lb, and 5.8 min for 20 lb.

With the average unit time prescribed the average parlor cycle time can be found. Then knowing the man-minutes a cow the number of milking units that can be handled satisfactorily can be deduced. Here then is a simple solution for milking parlors under _average_ conditions; we are attempting to apply the queuing theory to estimate the extent of the disturbance caused to the routine by deviations from the average. For example, if the cows are slow to come in on one or more occasions in the milking operation, or slow (or fast) milking cows are included, does this affect the number of units that can be handled.

A comparatively new development in milking parlors in the U.S. and Europe is the herringbone layout (figure 2). It is a walk-through two-level parlor, with the cows being let in in batches. There are two stalls for each milking unit. The cows may enter the parlor through one or two doors; they may also leave through one or two doors.

In fall 1957 a herringbone parlor study was started at Purdue; this involved observation of one or two milking operations in each of 14 parlors. The sample was selected to provide installations with different numbers of stalls and by different manufacturers. In all observed cases the cows were fed a metered amount of concentrate ration in the parlor at milking time.

The observations were completed in July 1958. Since that time the Farm Buildings and Farm Economics Research Sections of the USDA have made a study and one or two universities are believed to have done the same; no results have yet been published.

RESULTS

The elements in parlor milking have been divided into two groups--those that are relatively independent of the number of milking units and those that are dependent upon the number of milking units (through the effect on parlor size and the number of cows let in at a time). The time values (table 1) have been based on the observations.

The potential rate of milking cows with different "unit time" allowed (table 2) shows that only with a unit time of over 5.0 minutes is an appreciable increase in output obtained by adding a fifth unit if stripping is practiced or a sixth if no stripping is practiced.

It is seen that outputs of about 50 cows per man hour are attainable allowing 1.2 man minutes a cow with machine-stripping, and about 60 cows an hour, 1.0 man-minute a cow, without machine-stripping.

To use six unit effectively with a unit time of 5 minutes allows only 0.83 man-minutes a cow (table 3); with eight units the routine time allowed is reduced to 0.62 man-minute.

The element times may be reduced somewhat below the figures given. In the case of let in and feed, if the cows are trained to come in rapidly or a moving electrified wire is used, an appreciable amount of time may be saved. On the basis of observation, reduction in the time for preparation of the cow is accompanied by a reduction in quality of the job. Machine stripping can be reduced or eliminated; in most herds it averages higher than the time allowed in the standards presented here. Removal time can be slightly reduced by pulling the unit off the cow in one simple movement. The time to apply the four teat cups is one of the least variable elements, with little possibility for reduction in time.

In parlors with six units or more it is common to see two men or a man and a boy operating. The labor efficiency in these cases is usually no more in terms of cows milked a man-hour than is ob-

tainable in other types of parlor operated by only one man. The potential output in the eight unit herringbone with two men is, of course, high (table 4). However, earlier studies in other parlors (2) and the present studies have shown that the addition of a second man in the operation of a single parlor almost invariably reduces the labor efficiency. Where the output from a single parlor operated by one man is insufficient, the addition of a second, separate parlor allows the necessary increase in total output without reduction in the labor efficiency.

In some cases the herringbone stalls have been place on one side of the milking parlor, with one milking unit placed between every two stalls. This layout does not permit the high efficiency of the two-sided herringbone parlor, in which the milking process is relatively continuous. In the one-sided parlor all of the units must be "worked off" the cows before the cows in the parlor can be changed. The labor efficiency in this layout is at the best about 80 percent that of the two-sided layout (table 5). As the number of units in the parlor increases and the unit time per cow decreases the labor efficiency decreases because of the increase in the idle time of the milking units.

Results of efficient operators in the field agree closely with the standards presented here, as would be expected (table 6). However, in many cases the labor efficiency was considerably below the potential standard. The reason for this was frequently

apparent, such as poor working routine, cows slow to come into the parlor, or a high average machine stripping time per cow.

CONCLUSIONS

The output of cows milked a man hour in the herringbone parlor is higher than that in other parlors where the number of units that can be handled by one man is less.

One man can handle four milking units in a two-sided herringbone parlor and milk up to 50 cows an hour, with an average unit time of 5.0 minutes, including machine stripping.

With no machine stripping 5 units can be handled and up to 60 cows an hour milked under similar circumstances.

The addition of a second man to a six milking unit parlor decreases the output per man greatly, although it may increase the total rate of milking cows by up to 50 percent. The one-sided parlor layout is inferior in potential efficiency to the two-sided layout.

Further studies are needed on the effect of deviations from the average routine.

(1) Dodd, F.H. and Clough, P.A., Agriculture (London) in Press

(2) Morris, W.H.M. and Boyd, L.L., Agricultural Engineering, 36(9) 595-598, September, 1955.

Table 1. Standard Times for Milking in Herringbone Parlors

Work elements independent of the number of milking units.   **Minutes**

Prepare cow, include washing off the udder and drawing
the fore-milk into a strip cup.   0.30

Apply unit, take the unit off the hook (where applicable)
and apply the teat cups to the teats (assumes that a
suspended unit and randal is not used). Pipeline
units were used in all cases.   0.17

Machine strip, pull down on the teat cup cluster and
message udder, prior to removal of the unit.   0.20

Remove unit, remove the unit from the udder and, where
applicable, hang up.   0.16

Work elements dependent upon the number of milking units.

	Number of units					
	3	4	5	6	7	8
Double-sided parlors	Man-minutes per cow					
Let in cows, open let in gate and door, let in cows, feed cows, close let in door and gate.	0.21	0.16	0.16	0.15	0.15	0.14
Travel, time spent in moving between work stations (excludes trips out to the yard or to the milk room).	0.11	0.13	0.13	0.13	0.13	0.13
Let out cows, open let out door and gate, let out cows, and close let out door and gate.	0.06	0.07	0.07	0.08	0.08	0.09
Single-sided parlors						
*Let in cows, open let in gate and door, let in cows, feed cows, and close let in door and gate.	0.14	0.14	0.14			
Travel, time spent in moving between work stations (exludes trips out to the yard or to the milk room).	0.11	0.13	0.15			
*Let out cows, open let out door and gate, let out cows, and close let out door and gate.	0.12	0.12	0.12			

*Although these elements vary with the number of cows let in and let out in each group, the data over this range (6 to 10 cows) do not show an appreciable difference. Therefore, a single average figure has been used for each element in the budget.

Table 2. Budget of Labor Output in Two-Sided Herringbone Parlors

a. One man, machine stripping

Number of units	Unit time 4.2 min/cow	Unit time 5.0 min/cow	Unit time 5.8 min/cow
	Cows per man-hour		
3	43.0[u]	36.0[u]	31.1[u]
4	46.6	48.0[u]	41.4[u]
5	49.6	49.6	49.6
6	50.0	50.0	50.0
7	50.8	50.8	50.8
8	50.8	50.8	50.8

b. One man, no machine stripping

Number of units	Unit time 4.2 min/cow	Unit time 5.0 min/cow	Unit time 5.8 min/cow
	Cows per man-hour		
3	43.0[u]	36.0[u]	31.1[u]
4	57.1[u]	48.0[u]	41.4[u]
5	58.8	58.8	51.7
6	59.2	59.2	59.2
7	59.5	59.5	59.5
8	60.2	60.2	60.2

"u" indicates that the number of units limits the rate of output. In all other cases, the man's time limits the rate of output.

Table 3. Budget of the Routine Time Available in Two-Sided Herringbone Parlors.

Number of units	Unit time 4.2 min/cow	Unit time 5.0 min/cow	Unit time 5.8 min/cow
	Man-minutes available per cow		
3	1.40	1.67	1.93
4	1.05	1.25	1.45
5	0.81	1.00	1.16
6	0.70	0.83	0.97
7	0.62	0.71	0.83
8	0.52	0.62	0.72

Table 4. Budget of Labor Output in Two-sided Herringbone Parlors
with Two Men Including Machine Stripping.

Number of units	Unit time 4.2 min/cow	Unit time 5.0 min/cow	Unit time 5.8 min/cow
	Cows per man hour		
3	43.0$^{u/}$	36.0$^{u/}$	31.1$^{u/}$
4	57.4$^{u/}$	48.0$^{u/}$	41.4$^{u/}$
5	71.4$^{u/}$	60.0$^{u/}$	51.7$^{u/}$
6	85.5$^{u/}$	72.0$^{u/}$	58.0$^{u/}$
7	100.0$^{u/}$	84.0$^{u/}$	72.4$^{u/}$
8	103.0*	96.0$^{u/}$	82.7$^{u/}$

"u" indicates that the number of units limits the rate of output.
In all other cases, the man's time limits the rate of output.
* Only with 8 units and 10 lb. yield is there any increase in the
output by eliminating machine stripping.

Table 5. Budget of Labor Output in a One-sided Herringbone with One Man Including Machine Stripping.

Number of units	Unit time 4.2 min/cow	Unit time 5.0 min/cow	Unit time 5.8 min/cow
		Cows per man-hour	
3	31.0	27.3	24.3
4	38.3	33.9	30.5
5	44.4	38.7	35.9
	Minimum milking unit idle time		
3	27.6	24.2	21.6
4	33.0	29.3	26.3
5	37.8	33.8	30.5

Table 6. Labor Output Observed in Herringbone Milking Parlors

Parlor #	Men	Units	Cows milked	Cows /hr	Cows/ m-hr	Cows/ unit/hr	Machine time/cow min	Net man-min/cow*	Delay min/cow	Predicted potential output MS	No MS
Two-sided Parlors											
5	1	3	26	39	39	13.0	4.6	1.27	0.27	39.5	39.5
6(a)	1	6	29	37	39	6.1	5.3	1.14	0.45	50.0	59.2
6(b)	1	6	29	43	43	7.1	5.5	1.18	0.26	50.0	59.2
7(a)	1	8	61	62	62	7.7	5.4	0.83	0.14	50.0	59.2
7(b)	1	8	61	60	60	7.5	5.6	0.87	0.13	50.0	59.2
8	2	6	60	52	26	.8.7	6.3	1.15	0.31	49	
9	2	6		48	24	8.0		1.13	0.55°		
10	2	6	48	57	28	9.4	5.2	1.04	0.55	58	
11	2	6	59	64	32	10.8	3.8	.95	0.55	92	
12(a)	2	6	53	52	26	8.6	6.1	1.15	0.55	53	
12(b)	2	6	53	57	28	9.4	5.3	1.08	0.55	67	
13(a)	2	6	60	29	14	4.8	9.1	1.12	0.55	40	
13(b)	2	6	60	37	18	6.2	8.0	1.12	0.55	44	
14	2	6	48				5.3	1.26	0.55	67	
One-sided Parlors											
1	1	3	12	21	21	6.8	8.1	1.49	1.43	Not available	
2(a)	1	4	26	-	-		4.3		0.26	38	
2(b)	1	4	26	27	27	6.8	5.1	1.76	0.43	34	
3(a)	1	5	37		-						
3(b)	1	5	37	46	46	9.2	3.5	.93	0.37	48	
4(a)	2	5	26	31	16	3.1		1.80	2.03		
4(b)	2	5	24								

° estimated

* excluding delay