Managing The Milking Parlor For Profitability

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The trend toward larger dairy farms is occurring in every region of the U. S. For example, in the two largest dairy states, California and Wisconsin, average herd size since 1950 has increased 950% and 290%, respectively (5). Similar trends can be seen in most other states. Today dairy herds in excess of 500 cows are common in all parts of the U. S. and herds over 1,500 cows are quite common in the Southeast and West.

An important factor which determines maximum herd size on the majority of large dairy farms is the number of cows which can be milked per day by the milking parlor. Therefore, selecting milking parlor size in new or renovated facilities is an important business decision which will impact the volume and profitability of the dairy operation for many years. In theory the formula for profitable milking is simple: combine optimal quantities of genetically superior dairy cows with properly designed milking equipment and facilities manned by highly trained and motivated employees. However, in practice the information available to guide dairy owners/managers in predicting the level of economic performance to anticipate from various parlor sizes and designs is scarce and confusing. Also, very little is available describing the best parlor management strategies (i.e., milking procedures, amount of milking labor) required to insure optimal return from the milking parlor investment.

Recent research at the University of Florida[7, 8, 11] has focused on integrating production and economic variables to determine more profitable dairy management strategies. This paper will focus on research investigating milking parlor profitability[8, 11]. Several common decisions the dairy owner/manager must consider in order to achieve maximum milking operation profitability will be examined, including:

1) pre-milking hygiene routine,

2) level of milk production,

3) milking frequency,

4) parlor size and configuration.

Double-20 and double-40 parallel parlors, which are common on large dairies, will be used in all comparisons.

Materials And Methods

It is nearly impossible to apply traditional experimental methods to complex systems like milking parlors. Also, it is not economically feasible to alter operating parlors to answer a variety of "what-if" questions. Therefore, we examined milking parlors using a technique called simulation modeling. Simulation modeling is a technique in which the real system (i.e., milking parlor, milking system, cows, and milking personnel) is imitated by a computer program. The computer program contains all of the logical and quantitative relationships between the milking parlor, milking system, cows, and milking personnel necessary to provide an accurate abstraction of the actual milking parlor system.

Our parlor simulation model[8] was built from data collected from over 60 large dairies. These data included survey data and over 100 hours of videotapes of large milking parlors in operation. The parlor simulation was validated by comparing it with the actual performance of parlors on four large Florida dairies. Table 1 indicates that the parlor simulation model was extremely accurate in predicting actual parlor performance for each of these four dairies with less than .5% difference between actual and simulated averages for number of cows milked per hour (CPH) or pounds of milk harvested per shift

Table 1: Comparison between actual and simulated milking parlor performance for four large Florida dairies.

dairy	parlor design	parlor size	actual CPH[1]	simulated CPH	actual MPS[2] (lbs)	simulated MPS (lbs)
A	herringbone	D-16	164 63	164 80	19,908	19,886
B	herringbone	D-20	206 60	207.60	32,509	32,628
C	parallel	D-35	320 20	319.20	46,176	46,077
D	parallel	D-40	362 51	361 60	59,467	59,745

([1] CPH = number of cows milked per hour.)
([2] MPS = total milk harvested per 3X milking shift.)

Table 2: Costs of totally equipped parlors including parlor building and associated equipment.

parlor	building area[1] (ft²)	building[2]	parlor equipment[3]	milking equipment[4]	automation equipment[5]	Total
Double-20 herringbone	11,833	$248,493	$184,245	$64,343	$57,629	$554,710
Double-20 parallel	10,824	$227,304	$180,737	$62,744	$49,990	$520,775
2-Double 20 parallels	21,428	$449,988	$322,318	$114,930	$99,980	$987,216
Double-40 parallel	20,064	$421,344	$310,631	$133,034	$99,980	$964,989

1: Building area includes wash and drip pens, cow platform and operator pit, milk room, equipment and service area for vacuum and refrigeration systems, office and adjacent restroom and storage area.

2: Based on a cost estimate of $21/ft2 of floor area which included all electrical and plumbing with poured concrete walls and modular metal roof construction.

3: Parlor equipment included stalls, gates, milk cooling and wash systems, and crowd gate.

4: Milking equipment included milking units, pulsation and vacuum systems, milk line, and receivers.

5. Automation equipment included automatic detachers.

(MPS) on 3x/d milking.

The parlor simulation model was capable of examining the effects of milking parlor design (herringbone vs parallel), milking parlor size (double-16 to double-40), milking system operating characteristics (vacuum: 12.5, 13.8, and 15.0 in Hg; pulsation ratio: 50:50, 60:40, and 70:30), milk yield, amount of milking labor, and milking procedures on milking parlor physical performance (i.e., cow throughput and milk output).

Additionally, a capital budget model was formulated[8] to examine the long term economic implications of selecting alternative parlor sizes, designs, and operating strategies. The budget model calculated the after-tax net present returns to ownership and non-parlor fixed costs (NPR) over a 15 year lifespan for each parlor. This budget model accounted for all revenues (e.g., milk, cull cows, and calves), all variable costs (e.g., feed, replacements, utilities, parlor supplies, veterinary and medicine, breeding, milk marketing, repairs, etc.), and all fixed costs (e.g., parlor construction, insurance, property taxes, etc.). Costs of totally equipped parlors are given in Table 2. All economic results reflect Florida's seasonal milk price and production and all comparisons were made at a 21,000 lb rolling herd average milk production.

The studies reported in this paper examined four issues relevant to the operation of large milking parlors: 1) pre-milking hygiene routine, 2) level of milk production, 3) milking frequency, 4) parlor size and configuration. Each issue was examined for its effects on parlor physical and economic performance. Two pre-milking hygiene routines compared were: 1) a full routine (Full) which included stripping, pre-dipping, drying with cloth or paper towels, and unit attachment, and 2) a minimal routine (Min) which only consisted of unit attachment. Both routines employed post-dipping.

RESULTS

Pre-milking Hygiene Routine

The decision of an owner/manager to incorporate a certain pre-milking hygiene routine is usually

determined by facility design and animal health (mastitis) concerns. Previous comparisons of CPH reported by Armstrong et al. (2) in parallel parlors showed that the full routine (Full) reduced parlor performance by 15-20% in double-20 to 24 parallel parlors. In the comparisons reported here cows were milked 3x and RHA was 21,000 lbs/cow. Our purpose is not to recommend one pre-milking hygiene routine over another, but to give dairy owners/managers an indication of the effects the two routines have on parlor physical and economic performance.

Table 3. Comparison of full pre-milking hygiene routine (full) and minimal routine (min) on cows milked per hour (CPH) and net parlor returns (NPR) for D-40 and D-20 parallel parlors.

routine	parlor size	CPH	NPR[1]
full	D-40	317	$3,536,686
min	D-40	383	$4,822,033
full	D-20	186	$2,222,813
min	D-20	258	$3,475,124

(1: Rolling herd average equals 21,000 lbs on 3x milking, milk price at $12.00/cwt. Returns are discounted over the 15-year expected useful life of the parlor.)

Table 3 presents the effects of the two routines on physical performance (CPH) and economic performance (NPR) for Full and Min pre-milking hygiene routines. Parlor physical performance (CPH) increased as the time required for pre-milking hygiene decreased (Min). This is expected because going to the Min routine eliminates pre-milking tasks that require over 8 seconds per cow to perform. When the Min routine was substituted for the Full routine, CPH increased 21% in the double-40 (317 vs 383 CPH) and 39% in the double-20 (186 vs 258 CPH). Higher physical performance (CPH) resulted in more milk output per day with a corresponding increase in parlor economic performance (NPR). The lifetime return potentials for either parlor increased over $1,250,000 by switching to the simpler routine. The percentage increase in performance for larger parlors to Min premilking routine will be less than smaller parlors. This is due to the fact that larger parlors are generally less efficient than smaller parlors because they have a greater opportunity for a breakdown in milking routine and any problems will delay the turn around time of more cows in the large versus small parlor.

Level of Milk Production

Rolling herd averages increase yearly in most dairy herds. Fifty pounds of milk per milking cow was an acceptable average in the 1950-60's. However, future levels of average milk production per milking cow will exceed 90 lbs or more. Research (9) has shown that milking time is heavily influenced by milk yield per cow. For example, a 1986 study (1) showed that the physical performance (CPH) of a double-8 herringbone decreased 25% when milk yield per cow increased from 35 to 61 lbs./cow/day. Therefore, it is extremely important for dairy owners/managers to select milking parlor size for new or renovated parlors to accommodate the increased levels of milk production anticipated over the expected life of the parlor.

Table 4 shows the effect of two RHA (22,000 and 25,000 lbs.) and milking frequency (2x or 3x) on parlor physical performance and parlor gross returns per month. Pre-milking hygiene in the double-40 and double-20 was Full. The results in Table 4 show that parlor physical performance was only slightly affected when RHA increased 3000 lbs. In the double-20 and double-40 parallel parlors there was almost no change in CPH for 2x milked herds when RHA increased from 22,000 to 25,000 lbs, and about a 2.5% decrease when RHA increased for 3x milked cows. A 2.5% decline in parlor throughput may appear small; however, if herd size is around 3000 cows it means you can milk 75 less cows per day. When the income from these 75 cows is lost there is no corresponding reduction in parlor fixed costs and a nearly imperceptible reduction in variable costs. Furthermore, a change from 22,000 to 25,000 lbs on RHA is only about a 14% increase. The percentage increase in RHA over the 15-year life of a parlor investment should be anticipated to be much higher.

Milking Frequency

Machine-on time is greater per milking for 2x cows compared to the same cows milked 3x due to higher milk yield per cow per milking. However, 3x cows have a lower average flow rate due to lower milk yield per milking. Data from several double-20 and 30 parallel parlors has shown that steady state throughput is 8-10% higher for herds milked 3x versus 2x[2]. A previous study evaluating the economics of 3x versus 2x milking[11] indicated that a response of 12-15% and a milk price over $14/cwt was necessary for 3x to be more profitable than 2x. This study did not consider fully utilizing parlor capacity to maximize parlor output.

Table 4 shows there were large decreases in CPH when milking frequency went from 3x to 2x at either RHA. Going from 3x to 2x at 22,000 or 25,000 lb RHA in either the double-20 or double-40 parallel parlor resulted in a 10-12% drop in CPH. These results show that it is critical to match parlor capacity to the anticipated milking frequency. Investigation of parlor gross returns (Table 4) showed, as expected, that more gross income is generated by higher RHA, but gross income is also increased by milking 2x versus 3x because more total cows can be milked 2x. Labor costs were the same on 2x and 3x because the total shift length, including set-up and clean-up, resulted in 24 hour/day parlor operation. Also, parlor fixed costs are unaffected by milking frequency. However, a 2x dairy would generate more costs due to larger land base requirements, expanded housing facilities, and greater waste disposal requirements due to the expanded herd size. Further economic studies of 2x versus 3x on large herds are needed, because even if profit margins on 2x cows are lower, total profit may be larger if parlor throughput can be increased to adequate levels to accommodate larger herd sizes.

Table 4: Effects of rolling herd average (RHA) and milking frequency on physical and economic performance of double-20 and double-40 parallel parlors.

milking frequency	RHA[1]	herd size[2]	CPH[3]	gross$/mo.[4]
		double-20		
2x	22,000	2046	186	479,294
2x	25,000	2046	186	503,511
3x	22,000	1518	208	343,736
3x	25,000	1482	203	355,840
		double-40		
2x	22,000	3784	344	871,443
2x	25,000	3751	341	910,174
3x	22,000	2781	381	626,955
3x	25,000	2716	372	648,741

1: Rolling herd average, lbs/cow/year

2. Herd size equals number of cows that can be milked per 11-hr shift (2x) or 7 hr, 20 min shift (3x).

3: CPH = cows milked per hr

4: Gross milk income per month @ $12.00/cwt

Parlor Size and Design

Milking parlor performance data from time and motion research[1] and simulation studies[8] has indicated that parlor performance efficiency decreases as a result of: 1) increased parlor size, and/or 2) parlor design (herringbone vs parallel)[3,8]. Parallel parlors outperformed similarly sized herringbones[3,8]. Thomas[8] showed that double-16 and double-20 parallel parlors outperformed their herringbone counterparts by about 13 CPH. This research also indicated, as shown in Figure 1, that smaller parallel parlors (i.e., double-16 and double-20) operated more efficiently than larger parallel parlors (i.e., double-32 and double-40). For example, a double-20 parallel parlor operated over 18% more efficiently than a double-40 parallel.

The primary reason for decreased performance with increased parlor size would be due to the interaction between parlor size and the time required to perform individual parlor tasks. All parlor tasks require a relatively short time to perform. For exam-

ple, it took about 4 seconds to attach a milking machine in a parallel parlor. However, a small percentage of the time it took perhaps 15-20 seconds. The same situation arises for all parlor tasks in that a small percentage of the time they will take much more time than usual. Since parlor tasks are performed sequentially, a task that requires a very long time will delay the performance of subsequent tasks and ultimately increase the overall cycle time for the cows currently in the parlor. This effect is even more detrimental to parlor performance as parlor length increases because a greater number of cows are affected. Plus, the possibility of a task taking a lengthy time increases as the parlor becomes larger simply because there are more opportunities for it to happen within a given milking cycle.

Parallel parlors enjoy a number of advantages over the herringbone. In parallels cows have over 35% less distance to travel to enter the parlor as compared to a herringbone parlor. This shorter distance reduces the first cow entry time by over 4.5 seconds in a double-16 and nearly 6.0 seconds in a double-20. In parallels the time required for milkers to walk between stalls during premilking preparation and machine attachment is also less and the average time to attach machines is generally 1.5 to 2.9 seconds shorter than in herringbones[1,8]. Individually these differences appear small; however, they are additive and thus increase work routine time and decrease parlor operating efficiency in herringbones. These differences in cow entry time and work routine also will allow the same number of

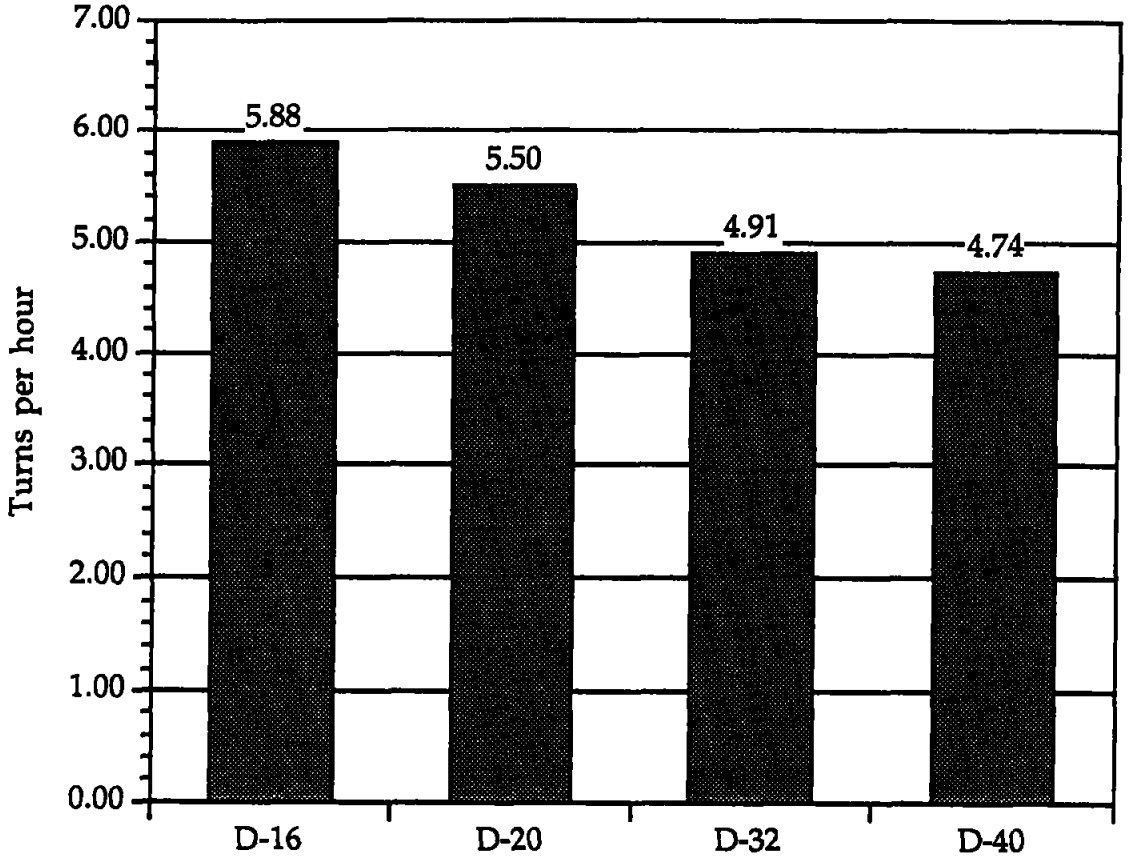

Figure 1. Performance comparison of four large parallel milking parlors.

operators to effectively utilize more milking units in a parallel versus herringbone parlor.

Table 2 presents cost estimates in the southeastern and southwestern U. S. for construction and equipment for double-20 parallel and herringbone parlors. The difference of $34,000 in cost only represents 6.5% of the totally equipped parlor cost. Using a 15-year planning horizon, 7.5% discount rate, and 34% tax rate, the difference in net parlor returns (NPR) favor the parallel by about $688,950. This economic advantage has little to do with the relatively small advantage the parallel enjoys in initial cost, but is primarily the result of its higher operating efficiency which allows higher cow throughput and thus a larger herd size to be maintained over its entire useful life.

Parlor costs for two double-20 and a single double-40 parallel parlor(s) are presented in Table 2. The difference in initial cost is $22,227 or 2.3% of the total initial cost. If the dairy design was an open corral with shade design typical of the southwestern U. S. the difference in corral costs for smaller pens necessary for the two double-20's compared to larger pens for a single double-40 would be approximately $60 per corral for extra lanes, fences, water tanks, etc. Table 5 shows the physical (CPH) and economic (NPR) performance for two double-20 parallels versus a single double-40 parallel. Differences in total corral costs are included. The advantage of 17% in CPH and 26% in NPR for two double-20's should be a major consideration for dairy owners/managers planning new parlor facilities or considering renovations of existing parlor facilities.

Table 5: Comparison of two double-20 parallel parlors versus a single double-40 parallel parlor for cows milked per hour (CPH) and net parlor returns (NPR).

	CPH[1]	NPR[2]
two double-20 parallels	371	$4,445,625
double-40 parallel	317	$3,536,686

1 Both parlors used Full pre-milking hygiene routine and 3x milking.
2· Based on RHA of 21,000 lbs per cow and $12/cwt. milk price. Net parlor returns are discounted over the 15-year expected life of the parlor

Conclusions

Selecting a milking parlor(s) is a major management decision because the choice will determine maximize herd size and impact profitability of the dairy farm for many years. Parlor design and size and management decisions on frequency of milking and pre milking hygiene routine all need to be considered in this decision. Future levels of milk production during the expected lifetime of the parlor should be considered but will be of less importance than other factors.

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notes