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MAKING DECISIONS REGARDING THE BALANCE BETWEEN MILK QUALITY, UDDER HEALTH, AND PARLOR THROUGHPUT

Introduction

Over the past 65 years the number of dairy farms in the US has decreased from approximately 4.5 million to 74 thousand. During the same period the number of cows per dairy farm increased from five to one-hundred twenty-five. The total number of dairy cows in this country decreased from 21.5 to 9.1 million while milk per cow increased from 4,500 to 19,000 pounds per year. The current national milk production could be produced by 8,000 dairy herds milking 1,000 cows each with an average production of 20,000 pounds per cow, thus requiring a further 90% reduction in the number of dairy farms.

As today's dairy industry consolidates, cows are being milked more rapidly through larger milking parlors on dairies larger than ever before. Because milk is the primary commodity and source of income for producers, the harvesting of milk is the single most important job on any dairy. Producing high-quality milk to maximize yields and economic value requires effective parlor management, an enormous challenge for producers. Managing large parlors includes managing labor, milking equipment, as well as monitoring and evaluating parlor performance. Decisions concerning the milking center are some of the most complicated decisions a dairy producer has to make. Milking procedures, herd size, milking interval, the milk market, and the equity position of a producer influence these decisions. Producers will have to make the following decisions before they can select or develop management protocols for a milking parlor:

1. How many cows will be milked through the parlor?
2. What milking procedure will be used (minimal or full)?
3. If a full milking routine; how much contact time do you want (strips per teat)?
4. Which milking routine will be used (sequential, grouping, or territorial)?
5. Are you willing to train teams of milkers to operate large parlors?

This paper will discuss the factors to consider when developing, selecting, and implementing a milking procedure and / or routine.

Options for Milking Procedures and Routines in Parallel and Herringbone Parlors

Typical milking parlor terms:

- Prep time–time taken to manually clean and dry the teat surface.
- Contact time–the actual time spent manipulating / touching teats and is the source of stimulation for oxytocin release.
- Prep-lag time-time between the beginning of teat preparation to the application of the milking machine.
- Milking Procedures–the individual events (i.e. strip, pre-dip, wipe, attach) required to milk a single cow.

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Milking Routines–define how an individual milker or a group of milkers carry out a given milking procedure (minimal or full) over multiple cows. In parallel and herringbone parlors; there are three predominant milking routines (grouping, sequential, and territorial).

- Grouping Milking Routine–In a grouping routine the operator performs all the individual tasks of the milking procedure on 4-5 cows. Once they have completed a group of cows they move to the next group of available cows.

- Sequential Milking Routine–Operators using a sequential routine split up the individual tasks of the milking procedure between operators and work as a team. Operators work as a team following each other performing their individual tasks.

- Territorial Milking Routine–Milkers are assigned units on both sides of the parlor and only operate the units assigned to them. When a territorial routine is used milkers are not dependent on other milkers to perform specific tasks.

The two predominant milking procedures are minimal (strip or wipe and attach) and full (pre-dip, strip, wipe and attach). Milking procedures impact the number of cows per stall per hour in parallel, herringbone and rotary parlors. In large parallel and herringbone parlors cows per stall per hour were 5.2 when minimal milking procedures were used and 4.4 when full milking procedures were used. Cows per stall per hour declined from 5.8 to 5.3 when a minimal routine was used compared to a full routine in rotary parlors (Armstrong et al. 2001). In large parlors milking procedures have a dramatic impact on the number of units one operator can handle in parallel and herringbone parlors. In 1997, Smith et al. published guidelines for the number of units that one operator could handle using a minimal and a full milking procedure. When a full milking procedure was used a milker could operate 10 units per side and 17 units per side when using minimal milking procedures. These recommendations were based on allowing 4-6 seconds to strip a cow and attaching all the units on one side of the parlor within 4 minutes.

In recent years several milking management specialists have been recommending 2-3 squirts per teat (8-10 seconds) when stripping cows to increase stimulation in an effort to promote better milk letdown, and to check for signs of clinical mastitis. Some of these management specialists believe that increasing the amount of stimulation reduces unit on times. At this time a strong data set supporting this theory does not exist. An AABP research update reported by Rapnicki, Stewart, and Johnson (2002) indicated that milk flow rate decreased when cows that had been previously stripped were no longer stripped. If pre-stripping is implemented, producers will have to reduce the number of units one operator can manage per side (Table 1). The sequencing of the individual events of the milking procedure is critical. Rasmussen et al. (1992) reported an ideal prep-lag time of 1minute and 18 seconds. Prep-lag times of 1-1.5 minutes are generally accepted as optimal for all stages of lactation. Some of the advantages and disadvantages of minimal and full milking procedures are listed in Tables 2 and 3.
Three predominant milking routines are used in parallel and herringbone parlors (sequential, grouping, and territorial). These milking routines are presented in Figure 1. The use of territorial routines will reduce throughput 20-30% when compared to sequential routines (Smith et al. 1997). Grouping routines seem to be an alternative to sequential routines without sacrificing throughput. Sequential

Table 1. Time (seconds) Required for Individual Events of the Milking Procedure.

Event	Procedure		
	Minimal*	Full * *	Full with 10 sec Contact Times
Strip	4-6	4-6	10
Pre-dip		6-8	6-8
Wip e	6-8	6-8	6-8
Attach	8-10	8-10	8-10
Total	12-18 seconds	24-32 seconds	30-36 seconds

Table 2. Advantages and Disadvantages of a Minimal Milking Routine.

Advantages	Disadvantages
Successful when cows enter the milking parlor clean and dry	Compromises teat skin sanitation
Time required to milk the herd may be decreased (total milking time)	"Machine on-time" may be prolonged
Steady state through put in increased	May require milkers to decide when extra cleaning of dirty teats is required
	Can cause lower milk quality and higher mastitis when compared to "full hygiene"

Table 3. Advantages and Disadvantages of a Full Milking Procedure.

Advantages	Disadvantages
Maximizes teat sanitation and milk letdown	Use 4 separate procedures or can combine in to two or three procedures
Minimizes "machine on-time"	Results in lower cow through put or higher labor cost compared to "minimal" or "none"
Use when maximum milk quality results are the goal	Requires more milker training to maximize results

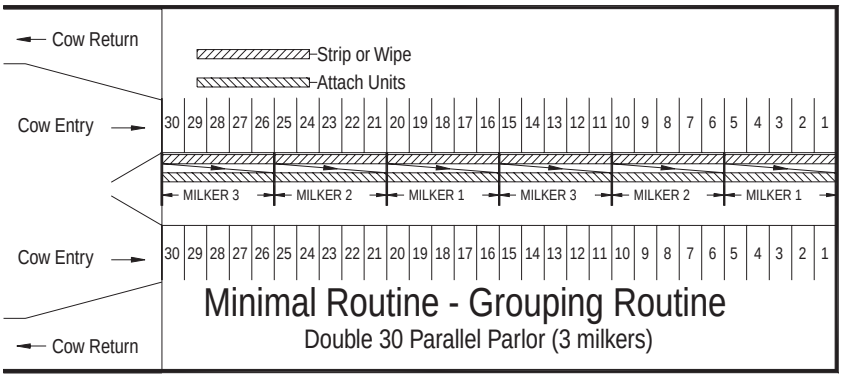
and grouping routines are demonstrated in Figure 2. Both full and minimal milking procedures in rotary parlors are presented in Figure 3. Although determining the “best” procedure and routine for every dairy is difficult, an often more serious problem is getting employees to understand and follow the recommendations of management.

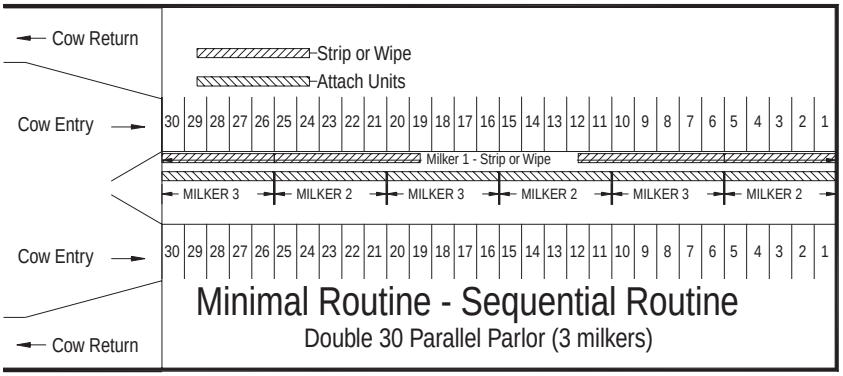
Rotary Parlors

Entry time (seconds/stall), number of empty stalls, number of cows which go around a second time, entry and exit stops and the size of the parlor (number of stalls) influence the performance of rotary parlors. The entry time will determine the maximum number of cows that can be milked per hour. For example if the entry time is 10 seconds, the maximum throughput will be 360 cows per hour (3600 seconds per hour / 10 seconds per stall = 360 cows per hour). This is referred to as theoretical throughput.

Theoretical throughput assumes that the parlor never stops, cows are milked out in 1 rotation and a new cow occupies every stall at entry. In reality, there are empty stalls, cows that go around a second time and times when the rotary table is stopped. Table 4 shows rotary parlor performance at different percentages of theoretical throughput. As the number of empty stalls, cows making a second trip around, and number of stops increases the percent of theoretical throughput is decreased.

The number of stalls or size of the rotary parlor affects the available unit on time. A rotary parlor must be large enough to allow approximately 90 percent of the cows to be milked out in one trip around the parlor.





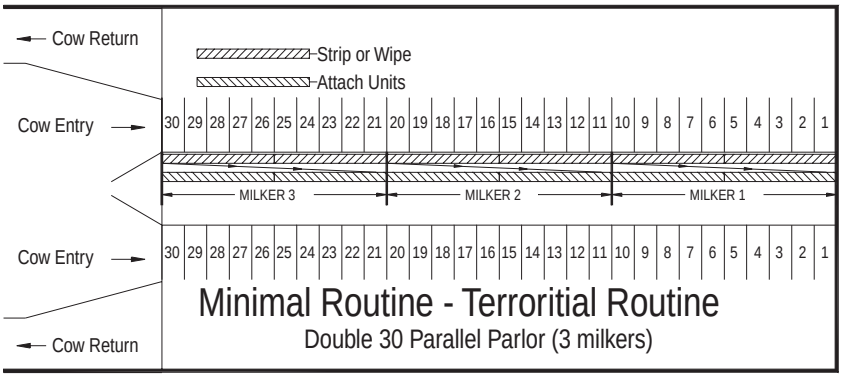
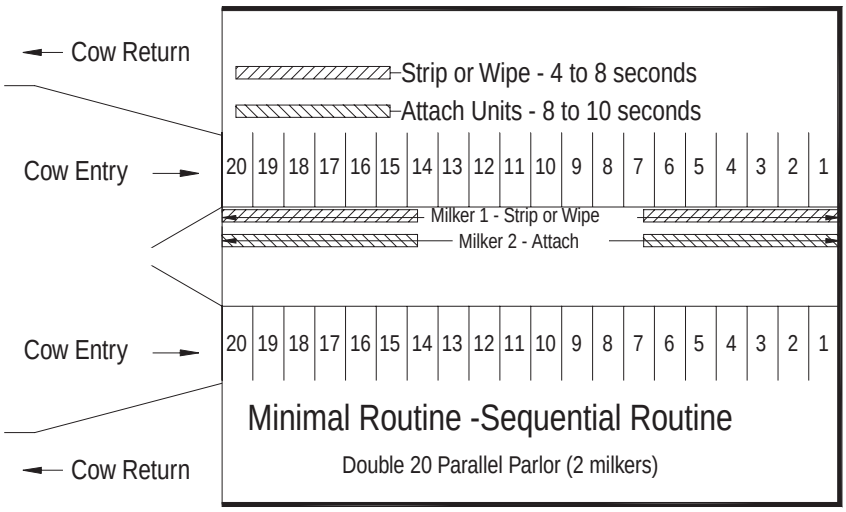


Figure 1. Different Milking Routines for Parallel and Herringbone Parlors



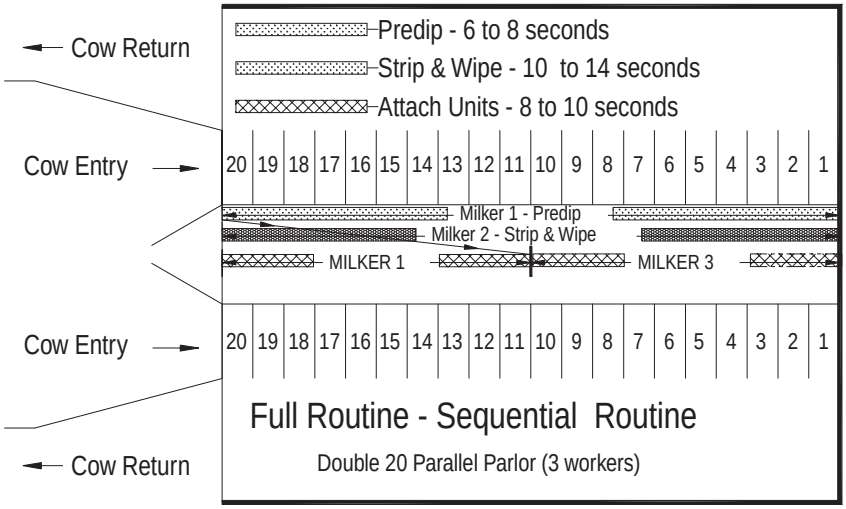


Figure 2. Sequential Milking Routines for Double 20 Parallel Parlors Using Minimal or Full Milking Procedures

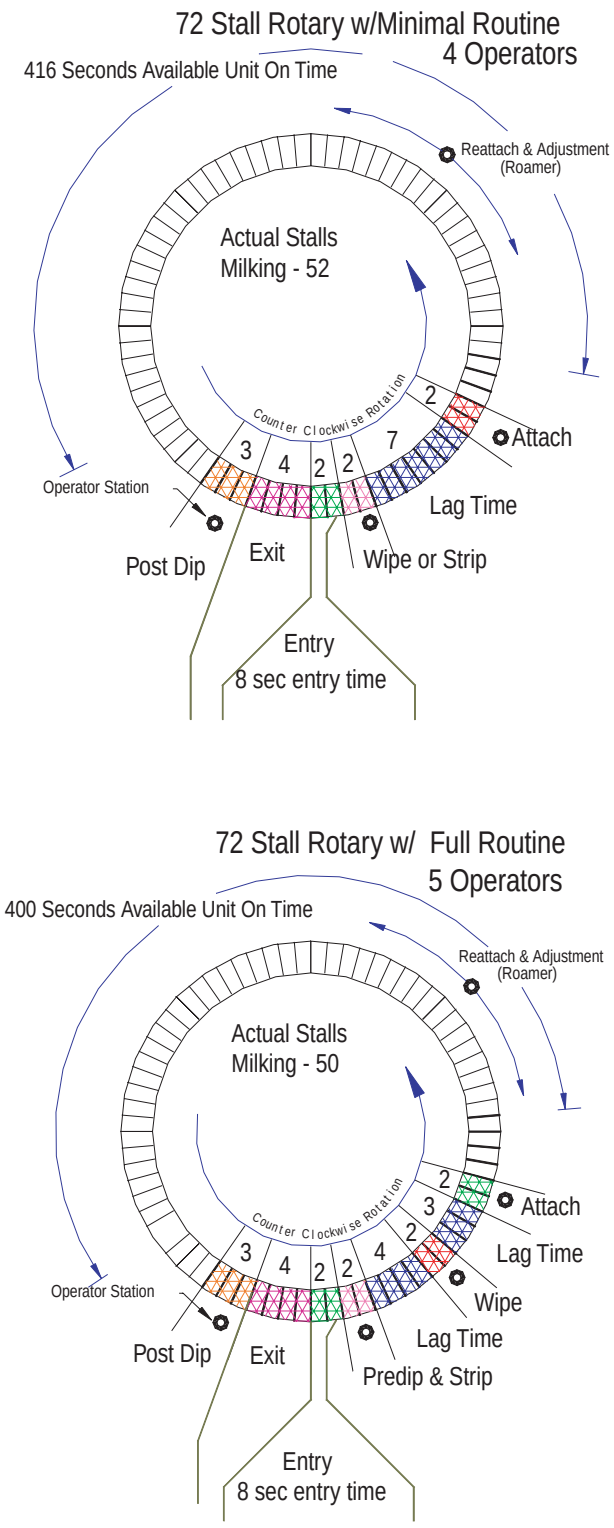


Figure 3. Minimal and Full Milking Procedures in Rotary Milking Parlors

Table 4. Rotary Parlor Performance (Cows per hour)

Time (sec/stall)	% of Theoretical cows/hr 100%	90%	80%	70%	60%
8	4 50	405	360	315	270
9	400	360	320	280	240
10	360	324	288	252	216
11	327	295	262	229	196
12	300	270	240	210	180
13	277	249	222	194	166
14	257	231	206	180	154
15	240	216	192	168	144
16	225	203	180	158	135

Measuring the Effectiveness of the Routine and Procedure Used

Regardless of the milking procedure and routine chosen, employees will be more receptive and effective at performing procedures if they have a role in developing them. Employers can learn from employees, and incorporating workers in decisions that affect their work improves morale and the working environment in general. Employee input is crucial! The easier a job is to understand, the easier the job is to manage. Keeping the routine as simple as possible and allowing employees to perform equal amounts of work will minimize employee turnover and improve labor efficacy. The challenge of many dairies is motivating milkers to properly clean teats prior to attaching units. Conducting a milker meeting to clearly explain the procedures expected in the parlor and why each step is important has proven successful for numerous dairies. Milking procedures should be written (in the language of choice) and given to all milkers prior to performing the procedure. Posting milking standard operating procedures (SOPs) on parlor walls so that all employees can clearly see them can be very beneficial.

Since there are numerous measures of milk quality, management needs a clear understanding of each of the measures and needs to establish clear goals with regard to each. Below are typical milk quality, udder health and general Clean In Place (CIP) sanitation measurements and the influence by both management and employees (adopted from VanBaale et al. 2001).

Standard Plate Count (SPC). The SPC is the total quantity of viable bacteria in a millimeter (ml) of milk. The SPC is a reflection of the sanitation used in milking cows, the effectiveness of system cleaning and the proper cooling of milk.

Employee Influence: The manner in which cows are prepared for milking.

Management Influence: The quality of water and the ability of the water heater to produce water of the appropriate temperature.

Laboratory Pasteurized Count. The LPC is a measure of bacteria that survive pasteurization. This group of bacteria has an influence on the flavor and shelf life of dairy products. The general sanitation of the CIP system and the condition of the rubber-ware can contribute to a high LPC.

Employee Influence: The manner in which cows are prepared for milking as well as attention to the condition of rubber goods and the wash-up.

Management Influence: The bacterial quality of the wash water and the choice of detergents and sanitizers.

Coliform Count (CC). The CC is a measure that reflects the extent of fecal bacteria exposure to milk. Coliform bacteria can enter milk as a result of milking dirty, wet cows or may result from coliform growth within the milking system.

Employee Influence: Employee hygienic practices have substantial control over the CC. The milking of clean and dry udders will limit exposure.

Management Influence: CC problems may be associated with a poor CIP system.

Preliminary Incubation (PI) Count. The PI count is a measure of bacteria that will grow well at refrigerator temperatures. The PI is controlled by strict cow sanitation, excellent system cleaning and proper cooling of milk.

Employee Influence: Udder preparation and sanitation has a positive effect on the PI.
Management Influence: The efficacy of the CIP washing system.

Somatic Cell Counts (SCC). Bulk tank milk SCC reflects the prevalence of mastitic quarters in the herd. An individual cow SCC reflects the number of quarters infected and the severity of those infections. Remember that SCC reflects both clinical and subclinical mastitic quarters being added to the bulk tank. If you are not identifying the clinical quarters and eliminating them from the supply, they can significantly influence bulk tank milk SCC. The economic influence of SCC on milk yield, milk quality, product yield, and product quality is significant.

Employee Influence: Regardless of the type of mastitis that affects a herd, the manner in which the cows are milked can have a significant influence on the rate of new infections. Despite the milkers' important role, a host of other factors may influence the somatic cell count. For example, the condition of the cow bedding environment and the commingling of chronically infected cows with noninfected cows ((in the milking parlor) are major risk factors over which the employee has little control.

Clinical Mastitis. A proportion of mastitis infections become severe enough to become clinical. The clinical signs include changes in milk appearance and may include signs of disease in the animal as well. Milk from cows with clinical mastitis cannot legally be included in the commercial supply. It is the milker's responsibility to assure that the disease is detected early and the milk is diverted for discard or noncommercial use.

Employee Influence: As is true for SCC, the employee has partial control over factors that influence the new infection rate. Similarly, the employee has partial influence over the clinical mastitis rate. However, critical practices like teat dipping and thorough drying of the udder before applying the milking unit are practices that affect the rate of new infection. A proportion of these new infections will become clinical. The employee has an additional influence on the manner in which cows with clinical mastitis are managed. Early detection of the disease is very important. Effective mitigation of the disease depends on prompt detection and management. A delay of eight to 12 hours can result in the incorporation of poor quality milk into the commercial milk, and may result in greater disease costs.

Teat and Teat-End Condition. The conditions of teats are a direct reflection of the cow's environment, teat dips being used, equipment settings, functionality, and up keep. In addition, the milking procedures and how well they are being followed impacts teat and teat-end condition.

Employee Influence: Adequately covering all of the teats, performing basic equipment checks and maintenance, and following a well designed milking procedure SOP to the letter.
Management Influence: Type of teat dip used, the condition of the cow bedding environment, implementing a well designed milk procedure and maintaining properly functioning equipment in the milking parlor.

Added Water. Milk is routinely tested for added water, using the freezing point test. Less than completely honest producers sometimes add water to the milk in order to increase the volume. Water may be added accidentally to milk by failure to drain the milking system fully before the milking begins.

Employee Influence: During wash-up and sanitation of the milking system the employee can assure that all excess water is drained from the system. In the case of farms that have a several-hour period between milkings, standing water in the system may also be associated with elevated bacterial counts.

Antimicrobial Drug Residues. Legally, most antimicrobial drug residues are not tolerated in milk. A few have legal tolerances, although the levels are extremely low. The type of drug and the manner of its application can greatly influence the potential for milk residues. Regulatory scrutiny has made dairy producers increasingly more accountable for eliminating drug residue in milk.

Employee Influence: Dairy farm management that instructs the employee to medicate cows for specific problems also must expect that the employee be able to withhold that milk from the commercial supply. This employee must know which cows are medicated and how long the milk is to be withheld. Some dairy farm employees are instructed in the use and interpretation of milk residue tests.

Sediment. The sediment in milk is a measure of the general filthiness of cows. This fine debris moves through the farm milk filter, and is detected by the milk processor. High sediments may be associated with higher bacteria counts. However, some bedding materials, like river sand, may contain very fine particles that are measured in the sediment evaluation.
Employee Influence: The general methods for cow and udder preparation will affect the amount of sediment in the milk.

If the above milk quality and udder health measurements are acceptable, then the milking procedure and equipment being used is most likely acceptable. Additionally, teat condition and teat end scoring should be done on a regular basis to evaluate the health of the udder.

Measuring Parlor Performance

Everything revolves around the parlor. Because parlors are fixed assets, increasing their use increases profits. Milking cows 21 to 22 hours a day, depending on the time required for properly washing the system, makes the best use of this asset. Milking parlor performance has been evaluated by time and motion studies (Armstrong and Quick, 1986) to measure steady-state throughput (cows per hour). Steady state throughput does not include time for cleaning the milking system, maintenance of equipment, effects of group changing, and milking hospital strings. These efficiency measurement studies also allow us to look at the effect of different management variables on milking parlor performance. Some typical efficiency measurements are:

Cows per hour (CPH). The total number of cows milked in one hour.

Cows per labor hour (CPLH). CPH divided by the total number of milkers.

Milk per hour (MPH). The total amount of milk harvested in one hour.

Milk per labor hour (MPLH). MPH divided by total number of milkers.

Turns per hour (TPH). Also called parlor throughput. The number of times cows enter and exit a parlor in one hour.

Parlor throughput can be further broken down into several individual time measurements such as:

1. From exit of the previous group until the first cow is touched (only if forestripping before pre-dipping).
2. From exit of the previous group until the first cow is pre-dipped.
3. From pre-dipping to drying (check minimal "kill time").
4. From exit of the previous group until the first unit is attached
5. From exit of the previous group until all units are attached
6. From exit of the previous group until all units are detached
7. From when all units are detached until exit again

Conclusion

One procedure or routine will not meet the needs of all dairy producers. The true test of a milking procedure and routine is in the end results relative to milking quality, udder health, and parlor throughput. Productivity is determined by people, which includes the caliber of employees, their level of motivation, and the effectiveness of management. Clearly defined goals need to be established, monitored, evaluated, and re-evaluated.

Managers must demonstrate interest in employees, meet with them regularly (at least weekly), provide feedback without attacking their ego and be sensitive to cultural differences.

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