MILKING PARLOR MANAGEMENT

MAKING THE RIGHT CHOICE

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INTRODUCTION

As the dairy industry consolidates, cows are being milked more rapidly through larger milking centers on larger dairies 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. Udder health and the subsequent production of quality milk determine the value of the milk being produced. By Making the Right Choice when it comes to sanitation practices, milk producers can enjoy the highest yields and profits.

Producing high-quality milk to maximize yields and economic value requires effective parlor management, an enormous challenge for producers. Milking parlor management includes managing labor, milking procedures and milking equipment, as well as evaluating parlor performance. The goal is to enhance profits by maximizing milk yield, udder health, and efficiency. This is accomplished by:

1. adequately training and motivating milkers and monitoring their performance
2. efficiently milking clean, dry, stimulated teats using proper pre- and post-milking hygiene
3. using properly functioning milking equipment
4. measuring parlor performance

LABOR

Employees are the most important resource on a dairy. Managers are responsible for employee training and development, and employees, in turn, are accountable to management.

Structure milking center labor. The milking center is the heart and soul of any dairy. Harvesting quality milk requires more than just milkers in a parlor. Typically a shift supervisor or leader will be directly responsible for the milking during their shift. Spreadsheets and other tools can be incorporated to monitor the daily activities in and surrounding the milking center.

- **Milkers** are responsible for following the milking routine to milk clean, dry, stimulated teats. This should be done efficiently, effectively, conscientiously and consistently throughout each shift.

- **Cow pushers** direct cow flow to and from the milking parlor. Their primary responsibilities are to provide a constant supply of cows in the holding pen and to return cows to their proper pens after milking. While performing these tasks, they are to handle cows gently and conscientiously.

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 it 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. Routine refresher training is also advisable.

Milking procedures should be written (in the language of choice) and given to all milkers prior to performing the procedure. It is also beneficial to have procedures posted on the wall in the parlor for everyone to see.

At some dairies, a portion of the milkers' salary is structured around their performance in the parlor how effectively they follow procedures. In other words, to achieve full salary, they must perform the milking techniques as outlined during the meeting. A major benefit of such a pay-for-performance program is that it allows milkers to make the full wage with the performance bonus if they simply follow the procedure. Milkers who lose the performance-based portion of their wage for three consecutive periods should be candidates for removal.

The remainder of this section on labor management is excerpted from a paper entitled *Milk Quality Incentives* by Dr. Richard H. Bennett, president, Applied Life Sciences (formerly extension dairy and public policy advisor, University of California-Davis).

Since milkers have considerable influence, the question of how to direct and motivate them to high standards of performance challenges the dairy industry. It is often suggested that incentives be used to motivate employees to improve performance. Incentive programs do work, but they must be well designed and must be part of a comprehensive program of employee supervision and training. The most successful incentive programs are those linked to measurable performance criteria.

Since there are numerous measures of milk quality, it is important that each is understood by dairy management. Overwhelming the employee with a program that tracks all of the milk quality criteria is unwise. Incentive program goals must be perceived as achievable. Hence, a more effective approach is to choose the criteria that are most important to the dairy or choose those that are most problematic.

The following is a short review of the major milk quality measurements:

Standard Plate Count (SPC). The SPC or Total Plate Count (TPC) 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 and the effectiveness of system cleaning. The production of high volumes of milk and the capacity to refrigerate milk quickly will assist in keeping the SPC low.

Employee Influence: Employees have a major influence on the SPC, such as the manner cows are prepared for milking. Factors out of the employees' control may affect the SPC, such as the ability of the water heater to produce water of the appropriate temperature. The quality of water on the dairy and mechanical systems will affect system cleaning and SPC accordingly.

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 milking process and system cleanup are critical control points. The condition of the rubber-ware in the milking unit and elsewhere in the system may allow milk to pass into the nonsanitary portions of the milking system. A broken liner, for example, can contribute to a very high LPC and SPC.

Employee Influence: The employee can affect the LPC by the manner in which cows are prepared for milking as well as attention to the condition of rubber- and hose-ware. Employees determine the effectiveness of the milk system cleaning. The bacterial quality of the wash water and the choice of detergents and sanitizers is outside of employee control.

Coliform Count (CC). The CC is a measure that reflects the extent of fecal bacteria exposure to milk. It may be direct, as in the case of milking dirty, wet cows, or it may be indirect, should coliform bacteria begin to multiply in the milking system.

Occasionally a cow with coliform mastitis may shed large numbers of bacteria into the milk. The CC is of particular importance as certain members of this group are capable of causing serious disease in humans.

Employee Influence: Good hygienic practices enable the employee to have substantial control over the CC. The milking of clean and very dry udders will limit exposure. Ongoing CC problems may be associated with a defect in the milking system that does not clean well. An employee’s influence depends on whether he or she is responsible for equipment maintenance.

Preliminary Incubation (PI) Count. The PI count is a measure of bacteria that will grow well at refrigerator temperatures. This type of bacteria is not commonly measured in the West, since all milk is processed daily. In the Midwest, many dairies have milk picked up every other day, and in some cases every third day. The PI is controlled by strict cow sanitation and excellent system cleaning.

Employee Influence: The regular and ongoing practice of superior udder preparation and sanitation has a positive effect on the PI. Dairy farm owners or managers that wash the system on a once-per-day or every-other-day basis may have elevated PI counts that employees will not be able to correct.

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.

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.

Somatic Cell Counts (SCC). The somatic cell count on bulk tank milk and individual cow milk is a direct measure of the severity of mastitis (udder infection). The incidence and prevalence of the disease on the dairy is subject to a wide variety of factors. In general, the SCC reflects only the subclinical or nonvisible form of the disease. The economic influence of SCC on milk yield, milk quality, product yield, and product quality is very 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 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.

Designing Incentive Programs

Incentives can be powerful motivational tools. However, if incentive programs are used for the wrong reasons, or used without careful thought given to their design, the best of intentions can "backfire" with the undesirable or unanticipated results.

If a milk quality incentive program is to be effective, there must be a willingness and ability on the part of management to train, support and communicate with the employees. There must be a belief, on the part of management, that the employees understand, are interested, and can implement the program for improving milk quality.

Regardless of the type or reason for incentives, several general points should be considered:

1. Incentives must have meaning. The employee who has a personal goal of earning and saving as much money as possible is not going to perceive incentives for extra days off with much enthusiasm. (Perhaps a monetary incentive would be more appropriate).

2. Provide training and communication. If employees have limited influence over the performance goal that is desired, it will be necessary to provide training and additional responsibility before a financial reward is instituted. This provides time to work out problems in communication and techniques before the employee begins to expect the reward for desired performance. In some cases the added responsibility may be sufficient reward. This is particularly true when one employee is chosen to lead several co-workers.

3. Incentives should be awarded in a regular and timely manner. Incentives, or other kinds of feedback, offered soon after the task is completed reinforce the desired performance behavior. If weekly or monthly performance data are available – for example, bacteria counts in milk – it is desirable to issue incentives on that basis as well. When rewards come only once a year for benchmarks achieved in the distant past, the employees may fail to associate the reward with the quality of the performance. Furthermore, a quarterly or annual reward may be too distant to positively motivate today's performance.

4. Performance incentives must be attainable. The desired performance must be understood, and the goal must be perceived by the employee as attainable. Many of the milk quality criteria are complex, and involve conditions that cannot be perceived by the human senses. Hence, management must be able to educate and train employees so they can clearly see how their performance affects the desired outcomes. Similarly, the employees must perceive that the goal is within reach, and within reasonable employee performance expectations. A farm that attempts to move from poor milk quality to superior milk quality in a very short time by placing responsibility solely on the employees is sure to fail. The employees will perceive the goal as unattainable, no matter how attractive the incentives.

5. Use appropriate performance measurements. It is imperative that management select the appropriate performance criteria to be monitored and linked to employee incentives. Incorrect monitors will quickly reveal themselves, as employees become frustrated by efforts that do not achieve the desired results. For example, most farm managers monitor total milk shipped on a daily basis. On occasion, daily milk production is monitored as a means of assessing the extent of mastitis in a dairy herd. The linkage between udder health and milk yield has been scientifically proven. It is incorrect, however, to extend that association and assume that all milk yield variation is due to mastitis. Clearly, management factors like nutrition and feeding have a far greater influence on milk production.

6. Anticipate the incentive message and employee actions. The largest pitfall of most incentive programs is that management fails to think the program through and anticipate the manner in which the incentive message will be perceived and acted on by the employees. A clinical mastitis detection incentive program provides an excellent example. Say a dairy producer had a significant problem with severe acute clinical coliform mastitis. Management believed that if these cases could be caught early enough, treatment would be more effective and less harm would come to the cow. The manager also believed that the milkers did not like to identify sick cows, as it required special handling of the cow that only slowed them down and prolonged the workday. In an attempt to deal with the problem, the manager instituted a financial incentive of five dollars for each case of clinical mastitis that was detected early. As a result, the detection rate nearly tripled and most of the cases were incorrectly diagnosed. The opposite is also true--if you pay for decreased cases of clinical mastitis you may initially find a decrease in the number of cases reported by employees, only to find elevated SCCs and more severe cases of clinical mastitis later.

7. Display ongoing performance information. Many good programs have faltered because management failed to share information. Was the employee expected to perform well, but not allowed to see how he or she was doing? Publish the data regularly. The farm computer makes it very easy to track milk quality results graphically. Produce and display these charts for all to see and update them weekly.

Special Considerations

A review of the major milk quality criteria indicates that employees do not have complete control over the quality of milk produced nor the rate of new mastitis infections. Since it is not possible to establish a perfect correlation between milker performance, milk quality, and mastitis control, dairy management must be able and willing to adjust the criteria when the situation warrants. For example, some dairy cows are kept in the herd, even though they are subject to recurrent episodes of mastitis. Data from this type of cow is not used in the determination of the incentive award.

Milk quality data can behave in ways that are somewhat unusual, i.e., subject to extreme variations resulting from specific farm conditions and practices. Techniques such as averaging, high and low throw out, seasonal averages, trend analysis, and zero tolerance are useful tools and will assist in the equitable measurement of performance.

1. Averaging. For data that does not differ by orders of magnitude; i.e., 10s, 100s, 1,000s, etc., simple averaging is appropriate. The bulk tank somatic cell count, for example, could be averaged over many weeks and the incentive goal determined by the monthly average value. In this manner one or two higher or lower counts in a short time period would not influence attainment of the goal.

2. High and low throw out. Milk quality data is subject to erratic and great variations. Throwing out the highest and lowest value for the month or quarter may be appropriate when a few erratic values are evident. All of the bacteria count data, SPC, LPC, CC and the PI, can behave this way. In contrast, prolonged elevation of bacteria counts is ~~a~~ very clear evidence of a problem.

3. Seasonal averages. In some locations, weather and management factors may change conditions, which employees cannot mitigate. In such cases, the average seasonal performance can be calculated to establish the norm or goal from which incentives are determined. Employee performance expectations should be adjusted for seasonal weather or management practices.

4. Trend analysis. Trend analysis, a sophisticated analytical tool, is useful for determining if any one or set of data points is within the normal and expected variation. Using trend analysis to set a course for improvement in performance is similar to the step-wise goal process. But instead of a series of steps, the goal is to follow a declining or inclining ramp. In step-wise analysis it is easy to tell when performance is "on step." If we have a straight-line goal for BTSCC, for example, how can we tell if any given SCC is on the proper trend? For those who use computers and spread sheets, the answer is easy. The trend is selected from the management goal, i.e., in the next 48 months, BTSCC should drop from 700,000 to 150,000 cells. A few months of data will determine and help predict the normal variation. The computer can then indicate which SCC values are better or worse than expected along the trend to lower somatic cell counts and award incentives accordingly.

5. Zero Tolerance. Some milk quality parameters may be too important to consider trend movement or step-wise movement. Zero tolerance is another form of fixed goal, except that the goal is no occurrences. Examples of the use of zero tolerance might include antimicrobial residues and added water. Both problems can subject the producer to economic losses and fines. The legal standard is zero occurrences. Effective antimicrobial residue avoidance requires that the employee have the knowledge, tools, and authority to act to keep the milk residue free. This requires knowledge of what drugs are used and which specific farm tests are needed.

Concluding Considerations

Employee incentives are powerful tools if used correctly and fairly. Management and employees must become very knowledgeable about the milk quality factor they choose to improve. They can obtain positive results by focusing on one problem at a time and by maintaining clear communications.

MILKING PROCEDURES

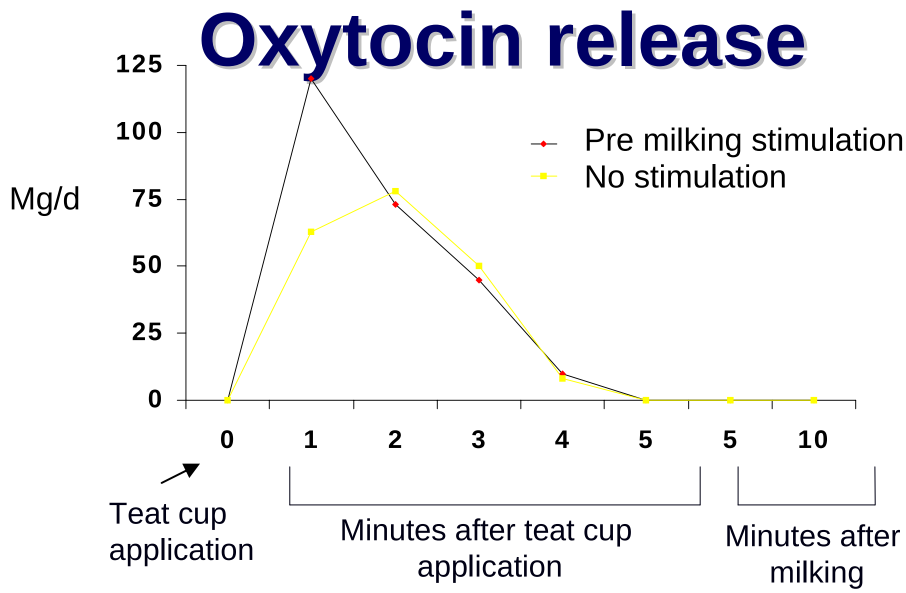
Proper premilking udder prep is a must in order to minimize clinical mastitis (especially from environmental organisms) and reduce somatic cell counts due to subclinical mastitis. Lower somatic cell counts return premiums for most dairy producers and also result in higher production.

Because profit is associated with increasing output of milk, it is important to efficiently milk as many cows as possible, and to maximize the amount of milk from each cow. The output of milk on a farm is a result of the number of cows milked and the amount of milk per cow:

Output = (number of cows milked) x (milk per cow)

Milkability is a relatively new term that refers to maximizing the amount of milk from each cow through good milking procedures and properly functioning milking equipment. Milkability is achieved when strong milk flow begins immediately after milking units are attached. Cows milk quickly and completely with a steady, high milk flow that quickly drops off at the end of milking. When automatic detachers are present, the milking units detach without further adjustment.

Key to good milkability is adequate stimulation. As cows enter a minimal stress environment and undergo stimulation, teats fill with milk – the result of oxytocin release. Oxytocin, a hormone released into the bloodstream, causes contraction of muscles surrounding milk-secreting cells. To achieve the full benefit from oxytocin, milking units should be attached 30 to 60 seconds after teats are filled (45 to 90 seconds after beginning of stimulation) and never longer than 180 seconds after.



In herds where more than 10 percent of cows experience a period of no flow during the first minute of milking, there is clearly an advantage to implementing improved udder prep procedures. Data generated by Dr. Steve Eicker and associates shows that 15 seconds of prep shaves 1 to 1.5 minutes off milking time.

Measures of good milkability include:

- **Peak milk flow.** A sensitive indicator of good milk ejection and equipment-related parameters. Flow rates for high-producing herds should be at least 9 lbs. (4 kg) per cow per minute. Milk time for cows producing 20 to 25 pounds (9 to 11 kg) of milk should be approximately 4.25 minutes, with an additional ¾ minute for each additional 10 pounds (4.5 kg) of milk harvested.

  - **Completeness of milking.** Occasionally stripping cows after detachment is an effective way to measure completeness of milking (it is important to sanitize hands when post-stripping to reduce the spread of harmful microorganisms). The optimal strip yield at the end of milking should be less than one pound. Proper prep and the quality and upkeep of milking system equipment are primary factors involved in achieving optimum strip yields. *Overmilking is more harmful than undermilking.*

  Several things may lead to incomplete milking. Frequent causes include:
  - inadequate stimulation
  - poorly designed liners or condition of liners
  - improperly sized short milk tubes or claw inlets, which cause partial closing of the short milk tube, or any additional restrictions between the claw and the milk line (i.e., kinked milk hoses, small-diameter sensors)

- clusters that do not have sufficient weight or do not hang properly on the udders due to connecting hoses that are too long, too short, twisted or poorly aligned in relation to the cow

- long milking times due to either low claw vacuum and/or takeoff settings set for too dry of a milk-out

Additional factors that have an impact on milkability are pulsation characteristics and cluster weight distribution.

Researchers are exploring the impact of the following factors on milkability, milk production, milk quality, and efficiency:

- **Effects of takeoff settings on milking times.** Proper pre-milking prep opens up opportunities to adjust automatic detacher settings to speed parlor throughput. Shortening the detacher delay time and raising settings for milk flow rates is proving to be a big time saver for many dairies. Exceptional pre-milking stimulation must be in place and adjustments must be gradual. When the excuse is "no time to prep," implementing the combination of good prep and detacher changes often makes a substantial difference in milking times.

- **Effects of vacuum level on milking speed per cow.** Higher vacuums milk cows faster, but udder prep must be good and overmilking must be kept to a minimum.

When changes are made, it is critical to monitor results. Some milk systems provide information after each milking that includes:

- milk per cow
- unit on time per cow
- flow rate per cow
- flow rate per cow in second minute
- time spent in milk flow less than 2.2 pounds per minute (1 kg)
- summary data such as milk/stall/hour

Comparing before and after measurements helps determine if changes are making a difference. Consistency of udder preparation is the most important factor in training cows to milk quickly and completely, thus improving herd milkability.

Milking procedure considerations

Cow preparation and timing are important when designing procedures to maximize quality milk production in an efficient manner. The goal is to milk clean, dry, stimulated teats at every milking.

There is no one best way to prep cows, but from a cow's perspective, the routine should be the same no matter the hour of the day or who is milking. Procedures need to be simple and designed with employee input to fit management, labor and the cow's natural response. *People produce milk, not cows.*

When designing a milking routine, enable employees to produce quality milk by:

1) working with them to develop a routine they can perform consistently
2) providing cows with a clean, stress-free environment so udders are as clean as possible when presented for milking
3) minimizing milking interval fluctuations

Milking procedures should:

1) stimulate milk let down
2) reduce microbial contamination in milk
3) maintain optimal residual milk without overmilking
4) decrease milking time
5) reduce the spread of contagious and environmental microorganisms

Many factors must be considered when practicing effective milking hygiene, including:

1) **Cow cleanliness.** Singe or clip the hair of udders and clip the switch or dock tails to improve udder cleanliness, milk quality, parlor throughput and milker attitudes.

2) **Wash pens.** If wash pens are used, they must contain enough sprinkler heads and be adequately sized (15 square feet per cow) to minimize stress and increase cow cleanliness. Typically, there should be 20 to 30 minutes in the wash pen followed by adequate time in the drip pen or holding pen to allow sufficient drying time. Strive to limit cow-standing time to less than one hour. Depending on parlor size and cow cleanliness, wash pens can speed up parlor throughput. Sometimes the main advantage of wash pens is cooling of cows during hot weather.

3) **Drip pens.** Cows must be dry when the milking machine is attached in order to achieve long-term udder health. Full-sized drip pens allow teats to air-dry and reduce the need for further drying in the parlor.

4) **Crowd gates.** Gates need to be used to assist cow flow towards the parlor, not as cow *dozers*. Used correctly, crowd gates can speed up parlor throughput. However, incorrect use may increase stress and reduce oxytocin release.

5) **Gloves.** Wear gloves during milking to decrease the spread of microorganisms.

6) **Teat dips.** Use a proven germicidal teat dip before and after milking to reduce both contagious and environmental forms of mastitis. Dip may be applied by spraying or dipping as long as coverage is complete. Ensure adequate contact time (varies by product) to effectively disinfect teats. Rubbing teat dip into the skin increases stimulation and helps the dip reach mastitis-causing organisms in skin crevices.

7) **Forestripping.** Removing two or three streams of milk from each quarter encourages milk letdown, eliminates microorganisms in first milk, and aids in clinical mastitis detection.

Forestripping is a very powerful signal to the cow to let down her milk. Though it requires more physical labor and often is resisted by the labor force, the addition of forestripping to the milking routine will improve milkout in many herds. Stimulating the cow for better oxytocin release and improved milk letdown results in increased peak milk flow and faster, more complete milk removal. Decreased unit-on times decreases mastitis and increases throughputs.

Following is an example of the power of proper premilking stimulation: A dairy added a third person at the front of a 48-stall rotary parlor so forestripping could be implemented. In two days, production increased by three pounds per cow. Teats were cleaner, there were fewer liner squawks, and unit reattaches decreased by more than 50 percent.

Some dairies do not forestrip and still get good stimulation. However, these herds are few and far between. Herds that do not forestrip tend to allow the milking machine to do the priming, which slows down milking times and creates undue stress on teat ends over time, resulting in increased mastitis prevalence.

Forestripping is also important for early detection of clinical mastitis. Without detection and management of mastitis cows, the remainder of the herd is at risk of contracting contagious mastitis.

Besides these benefits, physical stimulation (forestripping) aids in the removal of manure/dirt from the teats and udder, which improves milk quality.

It is important to forestrip before teat drying. If hands come in contact with milk, sanitize them between cows to prevent cross contamination.

8) **Teat drying.** Use an individual towel (preferably cloth) to effectively dry teat sides and ends. Cloths should be laundered and dried after each use. Check teat cleanliness with an alcohol pad or by shining a flashlight directly on the teat skin.

9) **Timing.** A minimum of 12 to 15 seconds of manual stimulation of the teats is required for sufficient nerve stimulation to ensure adequate oxytocin release and good milk ejection response. To take full advantage of oxytocin release, attach units within 45 to 90 seconds from the beginning of the udder preparation process. Field reports indicate a 25 percent increase in milk flow rates when units are attached within one minute of stimulation and a 10 percent decrease in production when unit attachment is delayed for more than five minutes.

10) **Unit attachment.** Attach units with minimal air inlet and align to ensure even milkout.

11) **Unit removal**. As soon as milk flow slows substantially at the end of milking, cut vacuum and remove unit gently. Dip teats immediately.

12) **Protect open teat ends.** Provide fresh feed for cows returning from milking to encourage cows to stand while teat ends close. This practice also allows more time for teat dip to remain in contact with teats, thus increasing the teat dip's efficacy. Germicidal barrier teat dips also protect open teat ends from environmental contamination.

13) **Milking intervals.** Time in between cow milkings is the "milking interval." Cows being milked two times daily should be milked every 12 hours; three times daily should be milked every eight hours; and four times daily, every six hours. Maintaining proper and consistent intervals will increase milk yield and improve udder health.

General milking procedures

Two types of milking routines typically are used in large parlors.

1) **Territory**: Occurs when individual milkers are assigned to an area or specific number of stalls. Milkers essentially work independently within the system. (For example, in a double-16 parlor, one milker may pre-dip, strip, dry and attach cows one through eight and the other milker will do the same on nine through 16).

2) **Rotating (also called sequential)**: Occurs when milkers work as a team to perform the milking routine together until all units are attached on one side. After attaching on one side they proceed to the other side to postdip the cows and release them.

The rotating routine is generally the most efficient. Research suggests that a rotating routine improves parlor throughput by 20 to 30 percent compared to a territory routine (Armstrong et al, 1994, Smith et al, 1995).

Table 1. Effect of different routines in parallel parlors

Parlor type	Pre-milking hygiene	Number of operators	Cows/ operator h	Turns/hr	Cows/hr
Double-50[a]	Rotating	4	136	5.45	545
	Territory	4	107	4.31	341
Double-16[b]	Rotating	2	68	4.31	135
	Batch	2	52	3.24	104

[a]F. Tumm, [b]D. Armstrong

In addition to considering efficiency and parlor throughput when choosing a routine, it's important to evaluate the routine's effect on milk quality and milkability. Maintaining consistency of udder prep is critical to milk quality and production. The following example routine accomplishes the goals of good udder prep.

Example of rotating milking routine in a double-24 parlor with two milkers

- While cows are loading, milker #1 predips and forestrips 1-12
- When milker #1 reaches 4, milker #2 begins drying and attaching 1-8
- Milker #1 dries and attaches 9-12
- Milker #2 pre-dips and forestrips 13-24
- Milker #1 dries and attaches 13-20 and immediately begins post-dipping on the adjacent side
- Milker #2 dries and attaches 21-24 and immediately begins post-dipping on the adjacent side

After all cows have exited and while a new group is entering:

- Milker #2 pre-dips and forestrips 1-12
- When milker #2 reaches 4, milker #1 begins drying and attaching 1-8
- Milker #2 dries and attaches 9-12
- Milker #1 pre-dips and forestrips 13-24
- Milker #2 dries and attaches 13-20 and immediately begins post-dipping on the adjacent side.
- Milker #1 dries and attaches 21-24 and immediately begins post-dipping on the adjacent side.

Assign areas of responsibility: Milkers are responsible to be in a specific area at a specific time during the milking. However, they should not be limited to any one area. In the above example, milker #1 follows the cows in and begins dipping the first cow as soon as she is in position. Milker #2 fills the parlor, secures the entry gate and begins his/her part of the routine. Their roles are reversed on the opposite end of the parlor. This type of procedure requires operators to be in certain areas but does not limit them to any one area, which allows for maximum efficiency during the pre-milking hygiene process. This procedure is also designed to minimize time between the exiting of the previous group of cows and the time when all milking units are attached to the new group.

Do not distinguish boundaries: Any time a cow is in danger or a unit is not attached correctly, the closest milker should tend to it, regardless of who originally attached it.

These procedures demonstrate one example of a routine that incorporates proper timing for good milkability as well as efficient use of milkers' time. Routines will vary depending on parlor size and configuration and the number of milkers. Once an appropriate routine has been designed, it should be performed consistently by all milkers during all shifts. The key is consistency from milker to milker and milking to milking.

UNDERSTANDING THE MILKING SYSTEM

The goal of the milking center is to optimize parlor performance by using functionally adequate equipment to efficiently harvest high- quality milk. Properly functioning equipment maintains teat-end health and minimizes backjetting of bacteria into the teat canal. Good maintenance limits leaks and cracks that harbor bacteria.

Variation in equipment management and type may impact the effectiveness of milk quality production strategies. However, the basic components (vacuum, pulsation, hoses, claws, etc.) within a milking system are relatively similar and require routine maintenance. The ability to understand and maintain milking equipment is imperative to quality milk production.

Recommended equipment settings

The following equipment settings have been adopted from W. Nelson Philpot, Ph.D., professor emeritus (Louisiana State University), and President of Philpot and Associates International, Inc., and his manuscript titled: Quality Milk Production and Mastitis Control.

Vacuum systems. The vacuum system includes the vacuum pump, vacuum controllers, main vacuum supply line, pulsation line, milk line and vacuum gauge. There are two types of vacuum on a milking system—a "system vacuum", which is the vacuum level on the milking system lines, and the "milking vacuum", which is the vacuum level in the milking unit during milking.

- **Vacuum pump** capacity should be adequate to meet the needs of the individual dairy. Research published by the National Mastitis Council shows that vacuum capacity should be 35 cubic feet per minute (CFM) plus an additional three CFM for each individual milking unit. Vacuum requirements for other equipment, such as air-lubricated vacuum controllers and vacuum-operated backflush systems, should also be considered. With the increase in parlor sizes, it becomes more important to consider the number of units being attached at the same time as this may impact vacuum requirements. This factor is especially true in systems with components that are more than 5/8 inch in diameter.

- The **vacuum controller** is a critical part of the milking system because it maintains vacuum level at a predetermined level by increasing or reducing the amount of air admitted into the milking system. This air is referred to as "reserve air flow." The controller should be located in a clean area on the main vacuum supply line between the vacuum distribution tank and the sanitary milk trap. Vacuum controllers often oscillate due to cyclic vacuum fluctuations produced by the pulsation lines. Controllers should be kept clean and serviced often to maintain proper operating condition.

- **Vacuum levels** will vary depending on what type of milking system is being used. A high milk-line system requires 14 to 15 inches of mercury (45 to 50 pKa), mid-level lines require 13.5 to 14.5 inches of mercury (45 to 49 pKa), and low lines require 12.5 to 13.5 inches of mercury (42 to 45 kPa) under average milk flow. Fluctuations during milking should not exceed 3 inches of mercury (10 pKa) in high-line systems or 2 inches of mercury (6.6 pKa) in low-line systems.

The most important aspect of vacuum levels is stability. During average milk flow, vacuum should range from 10.5 to 12 .5 inches of mercury (35 to 42 pKa) at the teat end. Milking systems are considered adequate if the milk-line vacuum remains stable within 0.6 inch of mercury (2 pKa) of the receiver vacuum during normal milking, including teat cup changing and liner slipping. Improved milking speed is achieved when the claw vacuum is maintained closer to 12.5 inches, with appropriate takeoff settings to minimize overmilking.

Pulsation systems. Essential to proper milking, pulsation systems alternately produce the milk and massage phases of the teat-cup liner. These phases are produced by the pulsation system admitting air and then removing it from the chamber between the liner and teat cup shell. Milk flows when the pulsator allows vacuum to be applied to the pulsation chamber, which opens the liner. This is known as the "milk phase." The "massage or rest phase" occurs when the liner collapses as atmospheric air is permitted to enter the pulsation chamber. Milking systems perform two basic functions: they impose a controlled vacuum on the teat end and provide intermittent massage to stimulate the teat and prevent congestion in the teat end. It is imperative that pulsators are kept clean and in correct operating condition.

- **Alternating pulsation** is preferred over uniform or simultaneous pulsation.

- **Pulsation rates** should be set between 45 and 65 cycles per minute.

- **Pulsation ratio** is the portion of the pulsation cycle when the liner is milking compared to massaging or resting. This should be set between 50:50 and 70:30 milk:rest ratio. Most researchers agree there is little benefit from pulsation ratios wider than 60:40. However, vacuum settings and pulsation phases must be taken into account when setting pulsation ratios. Pulsation problems may result from mechanical failure, liners with barrels that are too short, and inadequate rest phase. Any factors that promote fluid congestion in the teat end will predispose cows to an increased rate of infection. Some important factors are teat size, liner characteristics, vacuum conditions, depth of teat penetration into the liner, and compressive load on the teat during the massage phase of the pulsation cycle. Compressive load is applied to the teat by a relatively stiff liner, mounted under tension as it bends around the teat. The compressive load should be 3 to 5 inches of mercury (10 to 16 pKa) above atmospheric pressure. Raising the vacuum level or increasing tension on the teat-cup liner can increase the compressive load.

Milk removal system. A milking unit has four teat cups (each composed of a liner, shell, short milk tube, short pulsation tube), a claw, a long milk hose and a long pulsation hose. Milkers are more familiar with this unit than any other component of the milking system because they use it daily. The unit should be easy to handle, have sufficient capacity to prevent flooding, and should have an automatic shut-off valve to eliminate large air admissions during fall-offs or kick-offs.

- **Teat-cup liners** are the only parts of the milking system that come into direct contact with the cow's teats and have greater effect on milking efficiency than any other component. Selecting liners for individual dairies can often be a trial and error procedure. Liners should be changed every 1,000 to 1,200 cow milkings. Noticeable differences in milking efficiency after liners have been changed indicate that the change interval is too long.

It is important to minimize teat-cup liner slips during milking as slips can lead to machine-induced infections. More than five to 10 slips per 100 cows indicates a liner-slippage problem. Many factors contribute to liner slippage, including poor cluster alignment, poor liner design, uneven weight distribution of cluster, blocked air vents in the claw, and flooded milk lines. Other research has shown an increase in liner slips caused by an interaction of liner design, cluster weight, vacuum levels, vacuum fluctuations, milking wet teats, absence of hose support arms, overmilking and teat size.

Automatic detachers. Automatic takeoffs, or detachers, reduce labor time and should be set to minimize residual milk (without overmilking) and maximize udder health. To determine completeness of milking, periodically post-strip approximately 30 percent of the cows and measure the amount of milk left after the milking unit detaches. Cows are considered milked out if less than 1 pound remains from all four teats.

Maintenance of milking center equipment

Some equipment in milking centers needs to be checked daily by employees, but only serviced by experts as needed (vacuum, pulsation, cooling system, etc.). Other components, such as liners and hoses or any rubber pieces, should be replaced routinely, before crack or leaks develop. Some rules of thumb: liners - 1,000 to 1,200 hundred cow milkings; hoses or approximately every four to six months; air tubes - every six months or as needed; and pulsation hoses - annually or as needed. Some rubber pieces may last longer than others but it is important to never harvest milk with cracked or damaged hoses. These times will vary and depend on management practices and the equipment being used. Milk hoses and other components in the milking center need to be sized to optimize parlor routine efficacy and harvesting of quality milk.

Technological impacts of milking equipment

Advancements in technology have complemented management's ability to increase efficiencies and improve quality milk production. For example, in-line milk measuring systems used to measure milk quality and components can be used effectively to monitor milk quality. The fate of milking center technology depends on a manufacturer's ability to increase reliability and improve installation and maintenance, while keeping systems simple and user-friendly for producers.

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.

There are many ways to measure 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) exiting until full
2) pre-milking hygiene =
   a. dipping
   b. stripping
   c. drying
3) entry until first unit is attached
4) entry until all units are attached
5) all units attached until first unit detaches
6) all units attached until last unit detaches
7) last unit detaches until exiting

These measurements will vary from dairy to dairy depending on management and facilities. In addition to regularly evaluating these efficiency measurements, it is important to monitor the time and efficacy of the wash-up. While all of these measurements are useful to producers striving to become more efficient, it is critical to assess the impact on milk quality when implementing management practices designed to increase efficiency.

CONCLUSION

Quality milk production is imperative to the survival of dairy farmers in today's challenging market. Consumers are demanding a high-quality product and processors are willing to pay premiums for it. This module was designed to assist milk producers in Making the Right Choice, focusing on the management required in and around milking center systems as producers strive to enhance profits by maximizing milk yields and quality while optimizing efficiency.