Managing for Milk Quality

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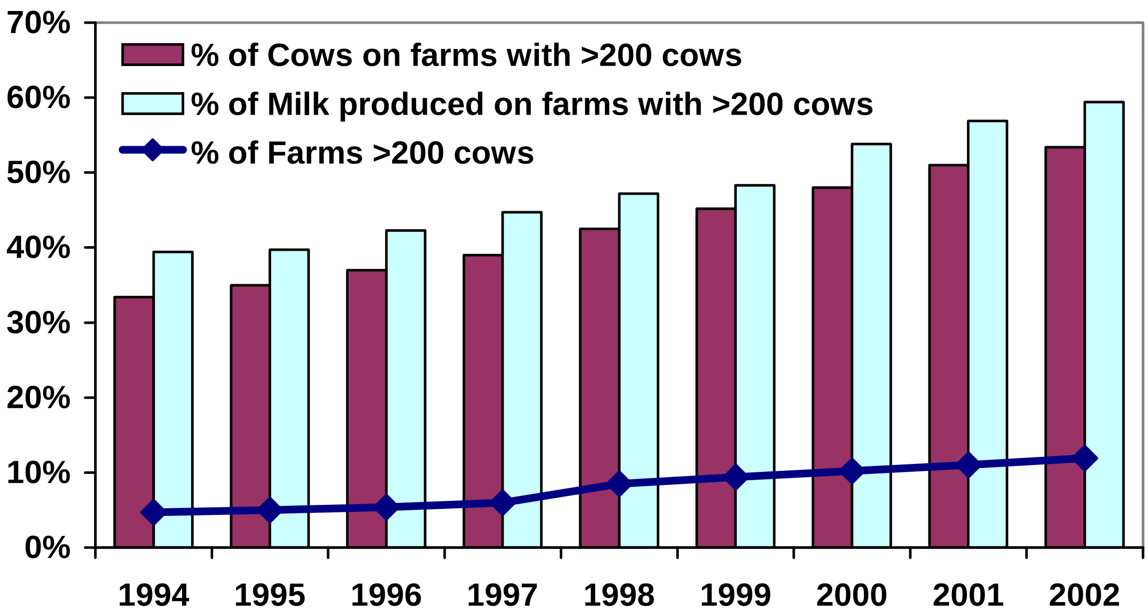
Introduction

Throughout the world, the business of dairy farming is rapidly evolving. Consumption of dairy products remains strong but fewer farms are producing more milk using less labor and more purchased services. In the United States, the number of dairy farms dropped from 192,700 in 1990 to 92,000 in 2002 (Wisconsin Agricultural Statistics, 2003). The productivity of these larger farms has increased steadily and an increasing percentage of milk is produced on farms that contain more that 200 lactating cows (Figure 1).

Figure 1. U.S. Trends in Dairy Farming, 1994-2002



These trends have resulted in specialization of farm labor and management of groups rather than individual animals. Today's dairy managers increasingly rely upon employees to milk and care for cows. The quality of the milk is directly dependent upon the ability of the farm manager to motivate employees to apply management practices that reduce exposure to environmental pathogens and eliminate transmission of contagious pathogens during the milking process. The image and concern about quality that a farm projects to employees will either motivate or discourage employees in their daily milking practices. Dirty farm facilities create the perception that hygiene doesn't matter. Managers that emphasize parlor throughput rather than quality cow preparation clearly indicate the priority of the farm management. Motivation and job satisfaction of employees is generally based more upon the perceived value of their effort rather than pay schedules. Dairy farms are unique because efforts to produce high quality product must occur every day and the task will never be completed. Education of employees is a smart management strategy that can return rewards in both better job performance and enhanced employee retention.

Exposure to Mastitis Pathogens
Exposure to mastitis pathogens occurs when large numbers of bacteria are able to successfully colonize the teat end. Mastitis organisms are classified as "contagious" or "environmental" based on the most common sites of exposure. The most common contagious mastitis pathogens are *Staphylococcus aureus*, *Streptococcus agalactiae* and *Mycoplasma bovis* but some strains of *Strep uberis* may be transmitted by milk (Zadoks, 2003). Many strains of *Staph aureus* and *Strep ag* are highly host adapted, result in subclinical mastitis and rarely cause acute episodes of clinical mastitis. The subclinical nature of these organisms results in costly infections of long duration. The udder of infected cows is the primary reservoir for contagious pathogens. Uninfected cows are exposed to organisms present in milk that originated from infected udders of other cows. Milk droplets on milking liners, shared towels or the hands of milking technicians are common sources of exposure to contagious pathogens.

Environmental mastitis pathogens include coliform bacteria (such as *E. coli* and *Klebsiella* spp.) and environmental streptococci (such as *Streptococcus uberis* and *Streptococcus dysgalactia).* Mastitis caused by coliform bacteria is often of short duration and <15% of affected animals usually develop chronic subclinical infections. Infections caused by environmental Streps may result in subclinical infections with periodic clinical episodes. Moisture, mud, and manure in cow housing areas are the primary reservoirs for environmental mastitis pathogens. Exposure to environmental pathogens often occurs in areas outside of the milking facility (such as housing areas, pastures or walkways). When the teats and udder are wet and dirty, large numbers of these bacteria have the opportunity to infect the udder.

Facility Hygiene
On many farms, the people that work in the milking parlor have the primary responsibility for mastitis control while other workers are responsible for stall maintenance and feeding. It is important to recognize that exposure to mastitis pathogens often occurs in cow housing areas and all workers that have the ability to influence exposure should share accountability for mastitis control. Manure handling, type of bedding and maintenance of cow beds all have significant influences on hygiene. Rapid movement of animals for handling or milking often results in splattering of manure. Overcrowding results in excessive deposition of manure in housing areas that are designed for fewer animals.

Cleanliness of animal housing has a major influence on the rate of clinical and subclinical mastitis. The risk of clinical mastitis was increased when maternity areas were not cleaned (Elbers et al., 1998, Peeler et al., 2000) and as the percentage of dirty stalls increased (Schukken et al., 1990, and 1991). Hygienic practices on herds with higher SCC values are generally poorer than hygienic practices on herds with lower SCC values (Barkema, et al., 1998, Hutton et al, 1990). Bedding was dryer (76% versus 68% dry matter) for herds with bulk tank SCC of $\leq$283,000 cells/ml as compared herds with higher SCC values (Hutton et al., 1990). A number of differences in facility hygiene were identified for herds categorized on SCC value (Barkema, et al., 1998). Dirty milking parlors were found for 15% of herds with SCC <150,000 cells/ml but for 31% of herds with SCC >250,000 cells/ml (Barkema, et al., 1998). Herds with SCC > 250,000 cells/ml also had more manure in stalls, cleaned stalls less frequently, used less bedding on stalls and used more straw bedding.

In a small, random sample of Wisconsin dairy herds (n = 40 freestalls), the largest influence on stall hygiene was the type of bedding (Salgado and Ruegg, 2004, unpublished). The percentage of freestalls characterized as “dirty” was 27% and 66% for sand versus organic bedding respectively. Sand bedded stalls were characterized as “clean” even though new sand was added much less frequently as compared to stalls bedded with organic bedding types (8.4% of sand stalls received new bedding more than 1 time a week as compared to 82.4% of stalls receiving organic bedding types).

Bedding management is a primary determinant of bacterial numbers on teat ends (Bey, et al., 2002). The presence of large numbers of bacteria in bedding often results in outbreaks of environmental mastitis. High amounts of organic matter and moisture in bedding can support large numbers of bacteria. Sand bedding that is low in organic matter usually has the lowest bacterial populations. Anything that increases moisture content or the amount of organic matter in bedding will increase growth and exposure to mastitis pathogens. Excellent hygienic standards for housing and milking centers should be a goal of all dairy farms. Dirty facilities increase the risk of mastitis and exposure to other pathogens. Clean, well-kept facilities not only reduce mastitis but they help to instill pride in workers and are tangible evidence of commitment to quality.

Animal Hygiene

Specialization of labor may result in a situation where workers responsible for cleanliness of housing are not aware of, or adversely affected by the occurrence of dirty udders. The use of high concentrate diets has been associated with looser feces and reductions in cow and facility cleanliness (Ward, et al., 2002). Several studies have identified relationships between cow cleanliness and measures of milk quality (Barkema, et al., 1998, Reneau et al., 2003, Schreiner and Ruegg, 2003). A scale of 1 (cleanest) to 5 (dirtiest) was used to score 5 separate areas of cows and was compared to linear somatic cell scores obtained from the same animals (Reneau, et al., 2003). Cleanliness of the tail head, flank and belly were not associated with somatic cell scores but somatic cell score of cows with cleaner udders and lower rear legs was lower than SCS of cows with dirtier udders and legs, indicating that dirty cows had a higher prevalence of subclinical mastitis (Reneau, et. al., 2003). This study highlights the importance of maintaining cleanliness of areas that can contact the udder.

Udder hygiene scores (UHS) can be easily and efficiently obtained during milking using a visual scoring system (Figure 2). This system was used to repeatedly score 1250 dairy cows housed in freestalls on 8 Wisconsin dairy farms (Schreiner and Ruegg, 2003). Cows were categorized as “clean” (UHS of 1 or 2) or “dirty” (UHS of 3 or 4). Somatic cell counts and subclinical mastitis infections were higher for animals categorized as “dirty.” Significantly more environmental and contagious mastitis pathogens were recovered from milk samples obtained from cows with dirty udders as compared to cows with clean udders. Dirty cows reduce efficiency in the milking parlor and increase exposure to mastitis pathogens. Hygiene scores of udders should be routinely performed as a quality control measure just as body condition scores are performed to monitor nutritional management (Ruegg and Milton, 1995). Each cow with an UHS of $\geq$3 has an increased risk of mastitis. Of UHS obtained from 6,977 cows on 79 Wisconsin dairy farms (Salgado and Ruegg, 2004 unpublished), 21.2% were considered dirty, therefore it is reasonable goals for farms to maintain >85% clean udders.

Management of the Milking Process

Statistics from Wisconsin farms that use freestalls and participated in a milk quality program during 2000-2003 (n = 101) indicate that management of the milking parlor is often neglected (Ruegg and Rodrigues, 2004, unpublished). On participating farms (average herd size of 377 milking cows), there were approximately 6.4 different people milking cows each month, with a range of 2 to 16 separate individuals working in the parlor throughout the month. Training of milking technicians occurred relatively infrequently. Only 22% of the farms indicated that they held frequent training sessions for their milkers, 49 % of farms indicated that they trained milkers only at hiring and 29% indicated that milkers were never trained. It is difficult to understand how employees are expected to perform adequately because less than half (41%) of the farms reported that they had a written milking routine.

Many milking parlors on large dairy farms are used continuously and farmers may reduce udder preparation in an attempt to increase parlor throughput. Data from Wisconsin freestall operations (n = 101) indicate that the largest influences on cows per hour per operator (cows/hr/operator) are training frequency and the presence of a written milking routine (Table 1; Ruegg and Rodrigues, 2004, unpublished). In this dataset, the use of recommended milking practices was generally high. Of the farms, 89.1% always wore gloves when milking, 97% applied postmilking teat dips, 98% used predips, and 89% reported that milkers forestripped cows before attaching milking units. Frequent training of milking technicians resulted in the fastest milking speeds and the lowest monthly rate of clinical mastitis (table 1). The use of a complete milking routine (includes forestripping, predipping and drying before unit attachment) also resulted in faster parlor performance. The combination of a complete milking routine and frequent training resulted in the most efficient parlor throughput. Cows were milked at a rate of 52 cows per hour per operator when a complete milking routine and frequent training was used in contrast to 38 and 35 cows per hour per operator for herds that used an incomplete milking routine and frequent training or incomplete routine without training, respectively.

Table 1. Influence of Milking Routine on Performance for Wisconsin Freestall Farms

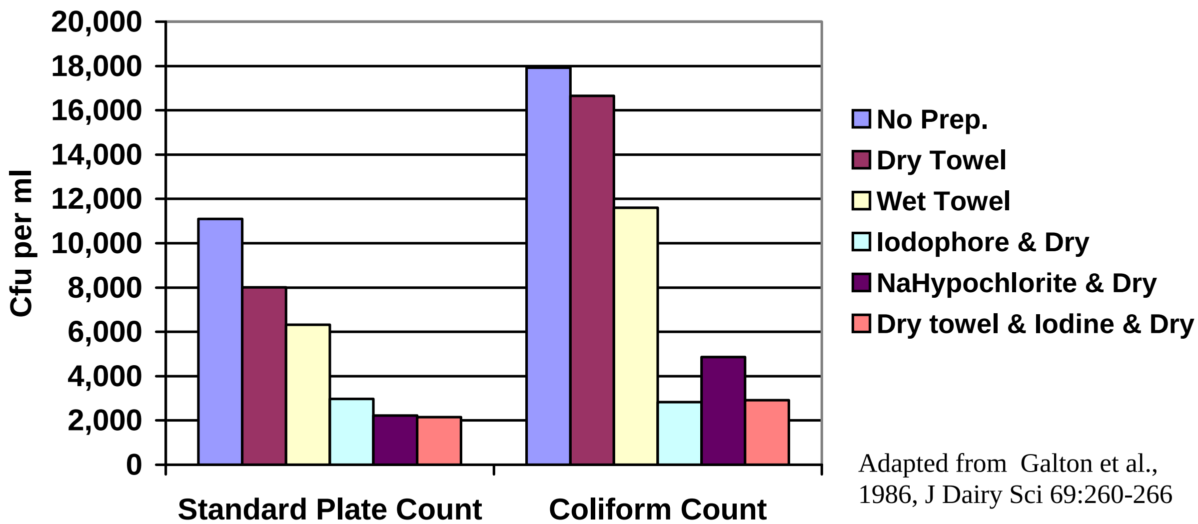
Variable		Cows per Hour per Operator	P value	Monthly Rate of Clinical Mastitis	P Value
Written Milking Routine	Yes	46.9	<0.001	5.0%	0.19
	No	35.6		7.1%	
Training Frequency	Never	33.6	0.003	9.6%	0.05
	At Hiring	41.6		8.3%	
	Frequently	49.4		5.8%	
Complete milking routine[a]	Yes	40.8	0.22	5.5%	0.03
	No	35.3		10.3%	
Predip	Yes	40.3	0.12	6.0%	0.02
	No	22.7		19.0%	
Forestrip	Yes	40.9	0.12	5.8%	0.16
	No	32.9		9.4%	
Wear gloves	Always	403.	0.52	6.2%	0.93
	Occasional	36.9		6.0%	

[a]routine includes forestripping, predipping, drying before unit attachment

Essential Aspects of the Milking Routine
Effective implementation of a milking routine that includes *forestripping, predipping, adequate drying* and *effective post-milking teat disinfection* should be the goal of all dairy farms.

Effective Predipping. Methods of premilking teat preparation have been extensively studied (Galton et al., 1982, Galton, et al., 1984, Galton et al., 1986, Pankey, 1989, Ruegg and Dohoo, 1997). There is no question that the most effective method to disinfect teats is to predip using an approved disinfectant. The use of pre-dipping using iodine has been demonstrated to reduce standard plate counts and coliform counts in raw milk by 5 and 6 fold, respectively as compared to other methods of premilking udder preparation (Figure 2; Galton, et al., 1986).

Figure 2. Effect of Udder Preparation on Bacterial Counts in Milk



Adapted from Galton et al., 1986, J Dairy Sci 69:260-266

Effective predipping also contributes to improvements in food safety. Predipping has been shown to reduce the risk of isolation of *Listeria monocytogenes* from milk filters obtained from New York dairy herds by almost 4 fold (Hassan et al., 2001). It is important to recognize that sufficient time and contact of the disinfectant with the teat is necessary for effective reduction in bacterial numbers. Teat dips need to be properly formulated, completely applied to debris free teats, and allowed sufficient time (30 seconds) for action before removal.

Forestripping. The examination of milk before attaching milking units is necessary to ensure that all abnormal milk is diverted from the human food chain and should be a standard practice on ALL farms. Similar to predipping, the use of forestripping has been shown to significantly reduce (2.5 times less likely) the risk of contamination of milk with *L. monocytogenes* (Hassan et al., 2001). Teat cistern milk contains the highest concentration of bacteria of any milk fraction. Forestripping is adequately performed when 2-3 streams of milk are expressed and is the most effective means to ensure adequate milk letdown.

When both predipping and forestripping are practiced, there is no data that indicates that the order that the steps are performed will have an impact on milk quality. In a subset of our data from Wisconsin freestall operations, milking performance was equal for herds regardless of which premilking procedure was performed first (Table 2).

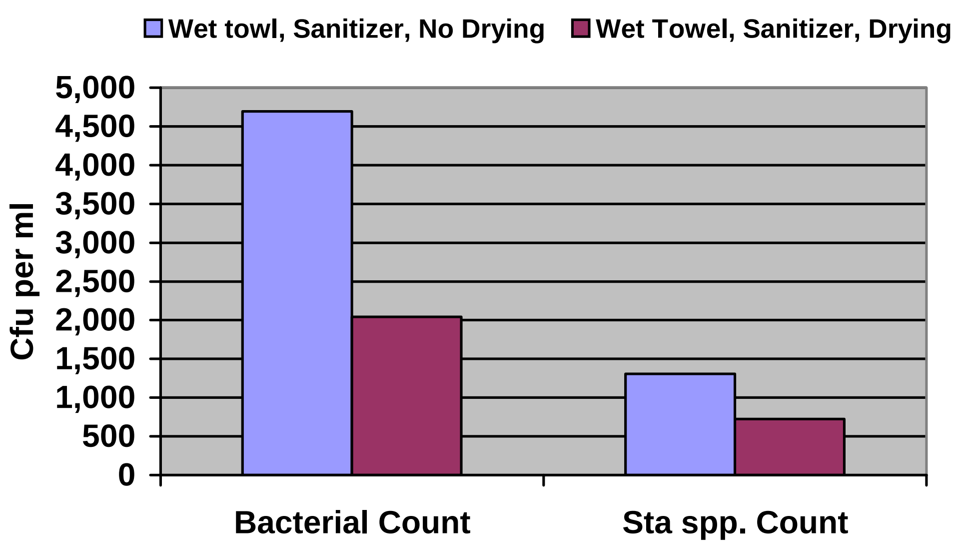
Table 2. Influence of Premilking Cow Preparation on Milking Performance for Wisconsin Freestall Herds that Perform both Practices (n = 72 herds)

Variable	Forestrip then Predip	Predip then Forestrip	P value
Cows per hour per operator	43.8	40.4	0.41
Monthly rate of clinical mastitis	5.8%	5.5%	0.76
Percent of cows with SCC >225,000	29.6%	32.1%	0.40
Milk per cow per day (kg)	32.5	32.6	0.91

On a practical basis, when teats are clean, it may be best to forestrip before teat end disinfection to reduce the opportunity to recontaminate teat skin. In milking parlors, cows can be forestripped onto the floor but the appearance of the milk should be noted to identify cows with mild cases of clinical mastitis. The use of gloves by milking staff is recommended to reduce the potential spread of mastitis pathogens by contaminated hands.

Adequate Drying. Effective drying of teats is probably the most important step in hygienic premilking preparation. A herd level study reported that herds that dried teats had bulk tank SCC values 44,000 cell/ml lower than herds that did not utilize this practice (Moxley, et al., 1978). In another study, drying reduced bacterial counts of teat ends from 35,000 – 40,000 cfu/ml for teats that were cleaned but not dried to 11,000-14,000 cfu for teats that were dried using a variety of paper towels (Galton et al., 1986). In Wisconsin freestall operations, 65% reported the use of 1 cloth towel per cow, 27% used 1 disposable paper towel per cow and 8% used 1 paper or cloth towel to dry udders on 2 cows. There are a wide variety of paper and cloth towels that are used to dry teats and recently the use of *wet towels to dry teats* has become popular. Moisture is an important growth requirement for bacteria and wet towels do not adequately remove moisture (Figure 3).

Figure 3. Effect of Drying on Bacterial Counts of Milk



Adapted from Galton et al., 1984, J Dairy Sci 67:2580-2589.

Cloth towels have the advantage of being more absorbent than paper towels but should be disinfected by washing with bleach or very hot water and drying at high temperature in an automatic dryer (Fox, 1997). Cloth towels should be of adequate size, monitored for wear and replaced when worn. The buildup of chemical residues on some towels made of synthetic fibers can reduce the absorbency and effectiveness of the towel.

Effective post-milking teat disinfection. Post-milking teat dipping is one of the most highly adopted practices in the dairy industry and it is the final hygienic defense against infection after milking is completed. The use of teat dipping reduced SCC values by 70,300 cells/ml in Quebec dairy herds (Moxley, et al., 1978). While teat dipping is universally recognized as a useful practice, effective implementation of teat dipping is often variable (Figure 4). Continued education of specialized milking staff about the principles of mastitis control is necessary to maintain excellent hygienic standards and minimize mastitis.

Figure 4. Inadequately dipped teats on a farm using dip cups.

Conclusion

Control of mastitis and production of high quality milk is dependent upon maintenance of excellent hygienic standards. Current production systems have created some new challenges for maintaining cow and facility hygiene.   Increased emphasis on monitoring animal and facility hygiene will be necessary to minimize the development of environmental mastitis and to ensure that milk continues to meet consumer demands.

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Figure 2. Udder Hygiene Chart – available at http://www.uwex.edu/milkquality/

MILK QUALITY RESOURCES
1-866-TOP-MILK

DATE: 4-15-03
FARM:
GROUP: (1) High cows

UDDER HYGIENE SCORING CHART

Score udder hygiene on a scale of 1 to 4 using the criteria below.
Place an X in the appropriate box of the table below the pictures.
Count the number of marked boxes under each picture.

SCORE 1	SCORE 2	SCORE 3	SCORE 4
Free of dirt	Slightly dirty 2 – 10 % OF SURFACE AREA	Moderately covered with dirt 10 – 30 % OF SURFACE AREA	Covered with caked on dirt >30% OF SURFACE AREA

Score 1					Score 2					Score 3					Score 4				
1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10
11	12	13	14	15	11	12	13	14	15	11	12	13	14	15	11	12	13	14	15
16	17	18	19	20	16	17	18	19	20	16	17	18	19	20	16	17	18	19	20
21	22	23	24	25	21	22	23	24	25	21	22	23	24	25	21	22	23	24	25

Total Number of udder scores: 59
Number of udders **scored 1:** 30
Number of udders **scored 2:** 7
Number of udders **scored 3:** 10
Number of udders **scored 4:** 12

Percent of Udders Scored 3 & 4: 22/59 = 37%

Udders scored 3 and 4 have increased risk of mastitis as compared to scores 1 & 2

Dairy Team Extension

 Chart developed with input from Dan Schreiner and Mike Maroney