Origin and Significance of Somatic Cells

What Are Somatic Cells

The term "somatic" refers to "derived from the body." Thus, somatic cells are "body cells." The somatic cell count (SCC) is composed primarily of white blood cells. The percentages of different somatic cell types in milk from healthy glands are: (1) macrophages (60%); (2) lymphocytes (25%); and (3) neutrophils or polymorphonuclear neutrophilic leukocytes (15%). Approximately 99% of all cells in milk from an infected quarter will be white blood cells, while the remaining 1% will be milk secretory cells that originate from the mammary tissues. Together, these two types of cells make up the SCC of milk, which is usually expressed on a "per milliliter" basis.

The SCC is the most widely used measurement for monitoring the inflammatory status of mammary glands and can be conducted on milk from: (1) individual quarters; (2) individual cows; (3) an entire herd; or (4) a group of herds. Somatic cells have a two-fold purpose in the udder to: (1) combat infecting microorganisms through a process known as phagocytosis, which involves engulfing and destroying them; and (2) assist in repairing milk secretory tissues damaged by infection or injury.

Herd Somatic Cell Counts

SCC information has many uses. Some of the more important uses are listed below.

- Monitoring the prevalence of subclinical mastitis in a herd, especially that caused by contagious microorganisms.
- Evaluating the severity and duration of infections in individual cows.
- Determining if the herd mastitis situation is improving or worsening.
- Classifying mastitis as being primarily contagious or environmental or both.
- Evaluating precalving and postcalving mastitis management.
- Identifying problem cows.

TABLE 7-1: Relationship between somatic cell count and infection status

Somatic cell count	Percentage of cows infected	
	Pennsylvania study	Cornell study
0-99,000	6	5
100,000-199,000	17	2
200,000-299,000	34	33
300,000-399,000	45	38
400,000-499,000	51	58
500,000-599,000	67	53
over 600,000	79	61

Source: R. J. Eberhart, et al. 1982. Journal of Food Protection. 14:1125.

TABLE 7-2: Summary of mean somatic cell count by infection status among several trials

Study	Mean somatic cell count/ml or range		
	Uninfected	Minor pathogen	Major pathogen
1	170,000	227,000	998,000
2	165,000	364,000	1,061,000
3	214,000	—	504,000 to 1,470,000
4	100,000 to 175,000	200,000 to 500,000	over 500,000
5	147,000	—	556,000

Source: J. K. Reneau. 1986. Journal of Dairy Science. 69:1708.

Uses of Individual Cow Somatic Cell Counts

Culture

Collection of milk samples for culture from individual cows or quarters with a high SCC is the best way to determine which microorganisms are responsible for mastitis in the herd. These data will be helpful in identifying specific control measures that should be implemented to control the targeted organism(s). Since the SCC on composite milk does not identify which individual quarter(s) are shedding high numbers of cells, it is often wise to use a cowside test, such as the California Mastitis Test (CMT), to identify specific quarters from which to collect milk samples for laboratory culture.

Treatment in Lactation

Infections caused by *Streptococcus agalactiae* have a high cure rate when treated in lactation, but this is often the only mastitis organism that should be treated at the subclinical level during lactation. Efficacy of treatment against most other pathogens will be disappointing. With *Staphylococcus aureus*, the cure rate will sometimes be as low as 10%. Thus, use of the SCC to select cows for treatment in lactation is not recommended. For more information of this subject, see Chapters 16, 19, and 24.

Culling

Culling is a useful method for eliminating cows that have chronic infections accompanied by a high SCC, especially if: (1) multiple quarters are involved; and (2) the animals have not been cured by prior treatment during lactation and/or at drying off. Culling decisions should be based on several factors such as: (1) a history of high cell counts; (2) type of infecting microorganism; (3) genetic value; (4) level of milk production; (5) stage of lactation; (6) age; (7) reproductive status;

(8) availability of herd replacements; and (9) other factors. Cows infected with *Staphylococcus aureus*, especially in multiple quarters, are often excellent candidates for culling.

Milking Order

If herd size and available resources permit, dairy producers should consider placing high cell count cows in a separate milking string so they can be milked after low cell count cows. This practice will reduce the possibility of spreading mastitis pathogens to uninfected cows during milking, especially contagious pathogens such as *Streptococcus agalactiae*, *Staphylococcus aureus*, and *Mycoplasma* species.

Early Dry-Off

If the cow(s) in question are in late lactation and are pregnant, consideration should be given to early dry-off and the administration of dry cow therapy. This practice will remove high cell count milk from the milk tank immediately. Moreover, treatment of cows at drying off with specially formulated, high persistency therapeutic products will result in a higher cure rate than if treatments are administered during lactation.

Withholding High Somatic Cell Count Milk

When dairy producers are in danger of having their license to produce and sell milk revoked, they can use SCC information to identify cows whose milk should be withheld from the milk supply. This procedure will usually lower the herd SCC so that raw milk can still be marketed while options for long term solutions to the herd mastitis problem are evaluated and implemented.

Selection of Cows for Herd Replacements

Dairy producers should exercise extreme caution when purchasing cows for herd replacements to avoid adding infected animals to the existing herd. If the prospective animals are lactating, it is advisable to review any existing cell count data such as Dairy Herd Improvement (DHI) records. It is also advisable to conduct a cowside screening test such as the CMT to obtain an idea about the current cell count status. If in doubt, milk samples should be collected and cultured in a laboratory prior to purchase.

TABLE 7-3: Relationship between linear scores and somatic cell counts

Linear score	Somatic cell count/ml	
	Midpoint	Range
0	12,500	0 to 17,000
1	25,000	18,000 to 34,000
2	50,000	35,000 to 70,000
3	100,000	71,000 to 140,000
4	200,000	141,000 to 282,000
5	400,000	283,000 to 565,000
6	800,000	566,000 to 1,130,000
7	1,600,000	1,131,000 to 2,262,000
8	3,200,000	2,263,000 to 4,525,000
9	6,400,000	over 4,525,000

Enhancing Milkability and Milking Center Efficiency

Introduction

The ultimate goal in any milking center should be to harvest a maximum amount of high quality milk with maximum efficiency, while ensuring excellent udder health. To achieve this goal, it is essential that: (1) milking center personnel be properly trained and motivated; (2) milking equipment be in peak operating condition; (3) cows be handled and milked in a calm and consistent manner at every milking; (4) teats be properly cleaned, dried, and stimulated using rapid and efficient methods; (5) milking units be attached to udders as soon as possible after adequate stimulation has occurred; (6) a high flow rate be achieved from each quarter soon after milking units are attached; (7) cows milk out completely; and (8) milking units be detached immediately after milk flow decreases to a preset threshold. These and other important considerations are discussed below.

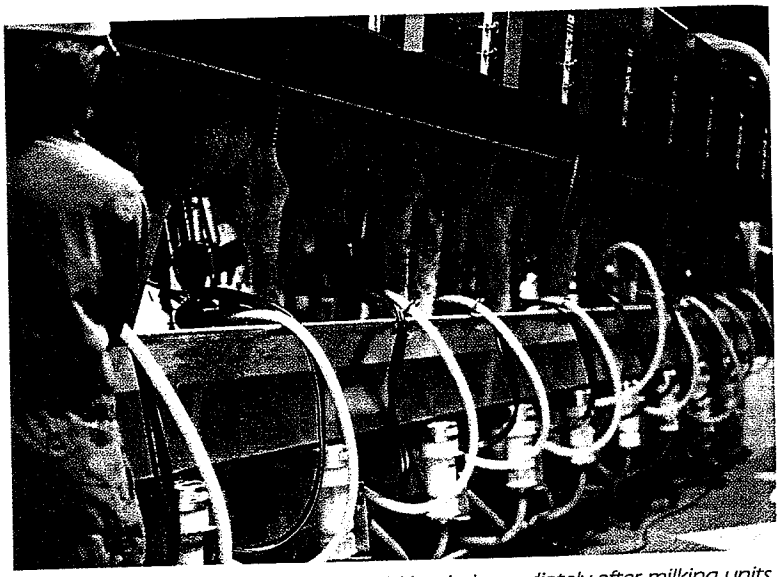

Photo 14-1. A strong milk flow should begin immediately after milking units are attached.

Enhancing Milkability

Milkability is a relatively new term introduced in recent years into the vocabulary of persons associated with the dairy industry. Milkability is achieved when "strong milk flow begins immediately after milking units are attached." Operators should be able to hear air bleeding into the claw via the claw air vent as the last teat cup is attached. Cows should milk quickly and completely with a steady, high milk flow that should slow suddenly at the end of milking. If automatic detachers are present, the milking units should detach without further adjustment.

This process is aided by bringing calm and clean cows into the milking center. Cows are creatures of habit and the fast and efficient harvesting of a maximum amount of milk requires their full cooperation. Milkability is enhanced when calm cows are prepped and milked in the same manner at every milking. The objective should be to milk teats that are clean and dry, but it must also be emphasized that 12 to 15 seconds of physical stimulation of the teats and lower udder is important in maximizing release of the milk letdown hormone oxytocin.

When teats of calm cows are stimulated for approximately 12 to 15 seconds, the teats will fill with milk and become turgid, indicating effective oxytocin release. Milking units should be attached quickly and efficiently 60 to 90 seconds after udder stimulation has been completed.

A basic goal of every dairy producer, manager, and employee should be to accomplish the task of "cleaning, stimulating, and attaching" in the same efficient manner at every milking. Though udder preparation procedures and milking centers will vary from one dairy farm to another, it is important that supervisory personnel develop a procedure that will accomplish this fundamental objective in a consistent and efficient manner.

Usually, the best procedure is to prep a small number of cows followed by attachment of milking units, and the sequence should then be repeated until all milking units are attached. When these objectives are accomplished in a consistent and effective manner, several things will result: (1) milk flow rates will increase as much as 25%; (2) milking time will be reduced; (3) yield will increase; and (4) udder health will be maintained, if not improved. Emphasis should be on developing and following a

"good routine" rather than a "quick routine." The practice of spending a few extra seconds on good udder preparation may: (1) reduce milking time by 1 to 2 minutes; (2) increase milk production; and (3) improve udder health.

Personnel should be trained to spend a couple of seconds adjusting milking units after attachment to ensure the milk outlet from the claw is pointed slightly down and is parallel with the cow's body. When this job is done correctly, the need to return to individual cows to adjust squawking teat cups will be minimized. In fact, the only time an operator should be required to return to an individual cow should be to: (1) detach the milking unit, if matic detachers are not present; and (2) apply teat dip.

Peak Flow Rates and Milking Time per Cow

The peak flow rate of a group of cows is a sensitive indicator of good milk ejection and equipment-related parameters. Flow rates for high-producing herds should be at least 9 pounds (4 kg) per cow per minute. New guidelines in the United States now use a figure of 12 pounds (5.5 kg) per cow per minute to ensure that the effective capacity of milklines installed at the time this book is being written will not become a limiting factor in another 10 years when milk yield and flow rates likely will have increased further. Milking time per cow should be approximately 5 minutes for cows producing 20 to 25 pounds (9 to 11 kg) per milking. One additional minute should be added for each additional 10 pounds (4.5 kg).

Completeness of Milking

The strip yield at end of milking should not exceed 0.9 pound (0.4 kg). If milking systems are correctly designed and maintained, and if milking units are attached and adjusted correctly, strip yield should be less than 0.5 pound (0.2 kg). Completeness of milking can be assessed by hand stripping 10 cows at random into a test bucket. Frequent causes of incomplete milking include: (1) poor type or condition of liners; (2) improperly sized short milk tubes or claw inlet, which causes partial closing of the short milk tube; and (3) clusters that do not have sufficient weight, or which 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.

Photo 14-2. Cows with properly prepared udders should have a peak flow rate of at least 9 pounds (4 kg) per minute.

Other Factors Affecting Milkability

Vacuum Level. Vacuum settings of 12.5 to 13.5 inches of mercury (42 to 45 kilopascals) [kPa] for low milkline systems and 14 to 15 inches (47 to 50 kPa) for high line systems will normally provide the desired mean claw vacuum level of 11.5 to 12.5 inches (38.9 to 42.2 kPa) during peak milk flow. Increasing the vacuum level will result in faster milking, but this benefit may be offset by higher strip yields. Vacuum fluctuations measured at the claw outlet under peak milk flow should not exceed 2 inches (7 kPa) for low milklines or 3 inches (10 kPa) for high milklines. Most specialists in the dairy field are convinced that more damage is done to teats by low vacuum and longer milking time than higher vacuum and shorter milking time.

Pulsation Characteristics. Increasing pulsation ratios from 50:50 to 60:40 or 70:30 will increase milking rate. A ratio of 60:40 is most common in the United States, but a ratio of 70:30 will milk cows rapidly and

comfortably if narrow bore liners are used and if the milking system is maintained in excellent condition. Pulsation rates of 50 to 65 cycles per minute are used most commonly.

Cluster Weight and Distribution. Increasing cluster weight aids in reducing strip yields, but may also result in increased liner slips and cluster falloff. The ideal situation is for most of the weight of the cluster to be in the four teat cups to provide equal weight distribution among the four quarters and thus enhance milkability.

Unit Alignment and Support. When clusters do not hang evenly, individual quarters will not milk out together and there may be an increase in liner slips. Milkability is improved by use of a hose support arm.

Liner Type and Condition. Liner design has a greater effect on milking characteristics than any other single factor. Teat congestion and edema are reduced by milking with narrow-bore liners having a soft mouthpiece.

Automatic Detacher Settings. Milking time can be reduced and teat end condition can be improved by raising the flow rate threshold and by decreasing the time delay before unit detachment. In one experiment, raising the flow rate setting from 0.44 pound (0.2 kg) to 0.90 pound (0.4 kg) per minute reduced milking time by 30 seconds and improved teat condition. Milk yield and milk composition did not change. Also, reducing the delay time from 20 or 30 seconds down to 10 seconds saved an additional 20 to 40 seconds.

Some specialists recommend a 12-second delay at a flow rate threshold of 1 pound (0.45 kg) per minute, or a 7-second delay at a flow rate threshold of 1.4 pounds (0.63 kg). In high producing herds with three times a day milking, the flow rate is often set as high as 2 pounds (0.9 kg) per minute with a time delay of only 3 to 10 seconds. Producers tend to have better results from these changes when they are milking three times per day rather than twice per day.

Automatic detacher settings should not be changed unless excellent milking practices are being used. The first change should be the time delay setting on the detacher. This is normally reduced incrementally at 5-day intervals until the desired delay has been achieved. Next, the flow rate threshold should be changed at about 0.1 pound (0.05 kg) every 5 days until the desired rate is reached.

Vacuum Regulator Response. Improvements in the efficiency of vacuum regulation have been shown to result in improvements in milking performance.

Cluster Air Admission. Air vents that are partially blocked will: (1) reduce claw vacuum; (2) increase vacuum fluctuations in the claw; (3) increase cluster flooding and liner slips; and (4) increase milking time per cow. Excessive air admission through the air vents will: (1) reduce claw vacuum; (2) increase vacuum fluctuations; (3) cause milk frothing and lipolysis; and (4) decrease milking time.

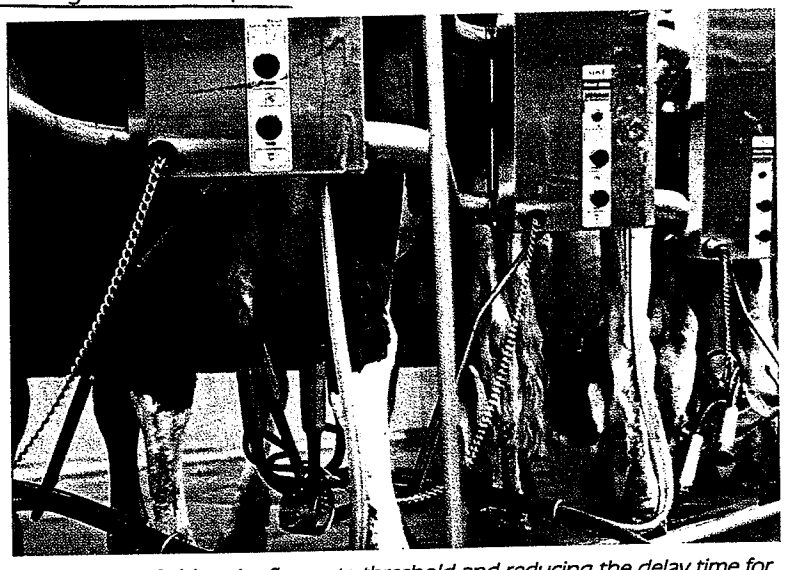

Photo 14-3. Raising the flow rate threshold and reducing the delay time for automatic detachers reduces milking time and improves teat end condition.

Turn Time in Parallel and Herringbone Milking Centers (Parlors)

Turn time can be defined as the number of groups of cows milked in the milking center per hour. This includes: (1) cow entry time; (2) udder prep and unit attachment time;

(3) unit detachment and teat disinfection time; (4) idle time; and (5) cow exit time. The national average in the United States is 2.75 to 3.0 turns per hour. However, a few milking centers staffed with motivated and highly organized employees are achieving a turn rate of 5.0 or more per hour, which occurs most frequently with herds milking three times a day. Perhaps a simpler way of viewing turn time is the number of cows milked per milking unit per hour. Suggestions for improving turn time include the following.

- Begin udder preparation before the entire side of the milking center is fully loaded, especially if there is more than one employee.
- [illegible] the cows to enter the milking center. Remember, cows are creatures of habit. If the employee makes it a habit to go to the holding pen to encourage cows to enter, it is likely they will see this as part of the normal milking operation.
- Use the crowd gate properly by training cows to associate moving forward in the holding pen with moving into the milking center. Improving this one procedure can improve turn times significantly.
- Train employees to attach milking units as quickly as possible after cows have been prepped.
- Eliminate "territories" in the milking center. Each employee should work until every milking unit has been attached.
- [illegible]nate liner squawks and unit falloffs.

Autorotor Carousel Parlors

The Autorotor Carousel is a rotating milking parlor designed for high cow flow with minimal manpower. Cows are brought to the operator at a constant speed as the platform rotates. Cows enter and exit continuously. Parlor output varies with the size of the parlor, milking time per cow, and rotation speed. Parlor platforms can accommodate from 16 to 80 stalls. Table 14-1 shows the cows per hour for the various stall configurations.

TABLE 14-1: Cows per hour in Autorotor Carousel Parlors

Cows per hour	Stalls per platform	Operators
365 to 548	80	2
310 to 435	60	1 to 2
250 to 350	48	1
200 to 280	40	1
160 to 225	36	1
135 to 180	32	1
115 to 150	28	1
100 to 130	24	1
90 to 120	20	1
75 to 105	16	1

A good rule of thumb is 225 to 250 cows per man hour for a typical 40-stall Autorotor Carousel parlor.

Since the cows come to the operator, there is much less wasted motion during milking. There is no need to walk back and forth through the parlor. A single operator can handle far more cows in less time than in a traditional parlor; however, for larger Autorotor Carousel parlors, it is recommended that operators be rotated between groups of cows to reduce fatigue and improve efficiency.

Cows quickly learn when to enter and exit the Autorotor Carousel parlor, so cow flow proceeds quickly and smoothly. The quiet operation keeps cows content for maximum milk letdown.

Persons in management positions ultimately determine turn time or milking center efficiency because they determine: (1) the type of milking facility that will be constructed; (2) the number of employees in the milking center; and (3) the procedures that will be included in the milking routine. Some authorities recommend using what they call the "3,600-second rule," which is the number of seconds in an hour. For example, if the milking routine is 40 seconds per cow, then the throughput of the milking center should be 90 cows per hour (3,600/40=90). The limiting factor in most milking centers is labor, and adding another employee to more fully utilize the milking center may not be economical. Producers must guard against a situation where the number of workers exceeds milking center capacity, and they must also avoid very large facilities that exceed labor allowances. There must always be a balance between labor cost per unit of milk harvested and idle time per milking unit.

Economic Importance of Mastitis

TABLE 3-1: Losses from mastitis (figured at $185.00 per cow)	
Herd size	Total loss
50	$9,250
75	$13,875
100	$18,500
150	$27,750
200	$37,000
400	$74,000
800	$148,000
1,600	$296,000

TABLE 3-2: Estimated losses due to mastitis per year		
Source of loss	Dollar loss per cow	Percent of total
Reduced milk production	$121.00	66.0
Discarded milk	$10.45	5.7
Early cow replacement costs	$41.73	22.6
Extra labor	$1.14	0.1
Drugs	$7.36	4.1
Veterinary services	$2.72	1.5
Total	$184.40	100

Source: Current Concepts of Bovine Mastitis, 4th ed. 1996. National Mastitis Council, Inc., Madison, WI. Page 2.

TABLE 3-3: Estimated losses due to mastitis per year				
	Pounds lost milk production per		Accumulated pounds lost milk production per	
SCC/ml	First lactation	Later lactations	First lactation	Later lactations
50,000	0	0	0	0
100,000	200	400	200	400
200,000	200	400	400	800
400,000	200	400	600	1,200
800,000	200	400	800	1,600

Source: Adapted from R. F. Raubertas, et al. 1982. Journal of Dairy Science. 65:419.

Economic Returns from Milk Quality and Mastitis Control

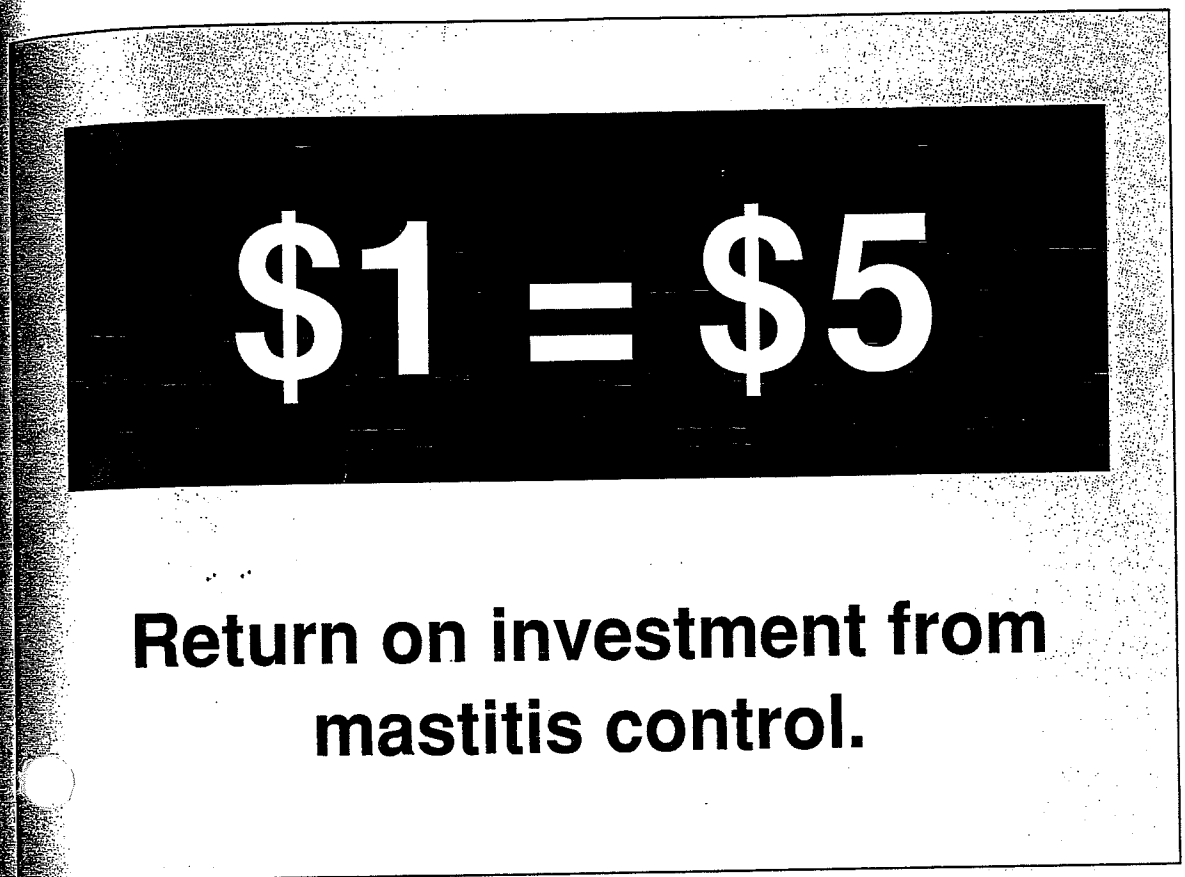

Figure 26-1. Mastitis control does not cost — it pays

TABLE 26-1: Costs and economic benefits of investing in specific mastitis control measures

Control measure	Cost	Benefit	Ratio
Postmilking teat dip	$8.87	$74.10	1:8.35
Dry cow treament	$8.27	$31.30	1:3.78
Wash udders with individual paper towels	$5.16	$27.26	1:5.28
Dry udders with individual paper towels	$5.14	$8.94	1:1.74
Inflations changed as recommended by:			
The service company	$6.62	$7.17	1:1.08
The dairy farmer	$5.15	$7.17	1:1.39

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current milk prices, this amounts to more than $130.00 year in additional me from increased milk production alone.

abnormal or contaminated with antibiotics.

- Less extra labor.
- Reduced drug costs.

comprehensive mastitis control program. Corresponding figures for milk fat were 10, 16, and 17% for the 3 years, respectively. A net return of more than 300%

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