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Animal and Plant Health Inspection Service

Veterinary Services

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Report 2

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Dairy 2014

Milk Quality, Milking Procedures, and Mastitis on U.S. Dairies, 2014

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Cover photograph courtesy of Dr. Jason Lombard.

Items of Note

Bulk-tank somatic cell count

Bulk-tank somatic cell count (BTSCC) refers to the number of white blood cells and secretory cells per milliliter of raw milk and is used an indicator of milk quality. The current legal limit in the United States is 750,000 cells/mL. In 2014, the national operation average level was 229,000 cells/mL and the milk weighted BTSCC was 193,000 cells/mL. The operation average BTSCC for all operations in this study was 206,500 cells/mL.

Milking facilities and equipment

There are two primary types of milking facilities: one in which milking equipment is moved to cows, such as a tie stall or stanchion barn, and one in which cows are moved to the equipment, such as a parlor. A slightly higher percentage of all operations milked cows in a tie stall or stanchion barn than in a parlor (52.6 and 45.8 percent, respectively). Milking facilities for very small and small operations (see Terms Used in This Report on page 3 for operation sizes) were similar, with nearly three-fourths using tie stalls or stanchion barns. Parlors were used to milk cows on 79.4 percent of medium operations and on 99.8 percent of large operations. Overall, 86.6 percent of cows were milked in a parlor and 13.1 percent were milked in a tie stall or stanchion barn.

For the 45.8 percent of operations that used a parlor, the parlor types used by the highest percentages of operations were herringbone and parallel (45.7 and 29.9 percent, respectively). The majority of cows on these operations were milked in a herringbone or parallel parlor (30.7 and 44.7 percent, respectively).

Automatic takeoffs (or detachers) are designed to remove milking clusters from the teats once milk flow decreases to a specified level. Using properly adjusted and maintained takeoffs prevents overmilking and maintains optimum teat-end condition. Almost half of all operations (49.1 percent) used automatic takeoffs. Almost all large operations (93.5 percent) used automatic takeoffs, while only 19.9 percent of small operations used automatic takeoffs.

On almost half of all operations (47.2 percent), owners or operators milked the majority of cows. On 65.9 percent of small operations, the owner or operator milked the majority of cows, while on 99.1 percent of large operations hired workers milked the majority of cows.

Standardized and consistently applied milking procedures increase parlor efficiency by providing cows with a routine that promotes effective and consistent milk let down and flow. Proper training of milking personnel is paramount in achieving consistent milking procedures. The percentage of operations that trained milkers on proper milking procedures increased as herd size increased. Overall, 59.8 percent of operations trained

milkers. On-the-job training was used on more than 90 percent of operations that trained milkers.

Increasing milking frequency can increase overall milk production. A total of 88.4 percent of operations milked the majority of cows two times per day. A higher percentage of operations in the West region than in the East region (18.8 and 9.4 percent, respectively) milked cows three times per day.

Glove use by milking personnel decreases the risk of transmitting pathogens between cows. To be effective, gloves must be cleaned or changed once they become contaminated. The percentage of operations in which milkers always used gloves increased as herd size increased (46.8 percent of small operations to 95.9 percent of large operations). Milkers on a higher percentage of operations in the West region than in the East region always wore gloves (85.5 percent and 56.1 percent, respectively). Milkers on 59.1 percent of all operations always wore gloves, while milkers on one-fourth of operations (24.5 percent) never wore gloves during milking.

Forestripping is the manual removal of up to 5 squirts of milk at the beginning of milking and is commonly used to evaluate foremilk for signs of mastitis. This practice also removes milk that has a high concentration of somatic cells, which can decrease the somatic cell count in the bulk tank. Additionally, forestripping improves milk let down and may improve parlor efficiency. Overall, 69.1 percent of operations used forestripping on all cows at each milking, and 11.6 percent of operations did not forestrip any cows. Three-fourths of all operations that forestripped cows (75.1 percent) did so before teat disinfection was applied or after disinfectant was applied, but before disinfectant was removed (dried).

Premilking teat disinfectants (predips) are used to reduce bacterial contamination on teat ends before milking. Using predips can reduce the amount of bacteria that enter the milk line and can also reduce exposure to mastitis pathogens. The majority of all operations (95.7 percent) used a premilking teat disinfectant; 55.5 percent of operations used iodophors.

Postmilking teat disinfectants (postdips) are applied to the part of the teat that was covered in milk residue during milking. Postdipping is important in preventing transmission of contagious mastitis pathogens, since milk is one of the methods of pathogen transmission. Overall, 96.8 percent of operations used a postmilking teat disinfectant. The primary postmilking teat disinfectants used were iodophors (69.4 percent of operations).

Barrier teat dips are meant to create an impermeable barrier at teat ends to prevent new Intrmammary (IMM) infections. The majority of operations (58.1 percent) did not use a

barrier teat dip. Almost one-third of operations (30.1 percent) used a barrier teat dip on all cows all the time.

Milk cultures

Culturing milk from individual cows with mastitis can help provide a prognosis and guide therapy. Bulk-tank milk cultures are important in identifying high levels of bacteria and contagious mastitis pathogens. Milk cultures were performed by 57.0 percent of operations; 45.4 percent of operations cultured milk from individual cows and 34.2 percent cultured bulk-tank milk. Of operations that cultured milk from individual cows, about half cultured all chronic or nonresponsive cases of clinical mastitis or cultured milk from cows with high somatic cell counts.

A similar percentage of operations used commercial and private veterinary labs to culture milk (47.2 and 39.0 percent of operations, respectively). Less than 10 percent of operations that cultured milk did so on-farm (7.9 percent).

Mastitis pathogens are considered either contagious (cow-to-cow transmission during milking) or environmental (transmitted from the environment to cows, typically between milkings). Although many bacteria can be transmitted both ways, most experts consider *Strep. agalactiae, Staph. aureus*, and *Mycoplasma* to be primary contagious pathogens. Cows are continuously exposed to environmental pathogens, so maintaining clean housing and bedding for cows is important in reducing exposure to these pathogens. Of operations that cultured milk, 79.9 percent identified environmental streptococci and 66.6 percent identified *Staphylococcus aureus.* Overall, 8.7 percent of operations identified *Mycoplasma* via milk cultures.

Mastitis incidence and treatment

Mastitis is inflammation of the mammary gland caused most often by bacterial infection. Producers on almost all operations (99.7 percent) reported having at least one case of mastitis during 2013. Clinical mastitis was detected in about one-fourth of all cows (24.8 percent) at some point during 2013. Almost three-fourths of cows with mastitis during 2013 (72.8 percent) recovered and remained in the herd, and about one-fourth of mastitic cows were removed/sold. Less than 5 percent of all cows with mastitis, regardless of herd size or region, died as a result of mastitis.

Owners and milkers were responsible for diagnosing mastitis on about three-fourths of operations (82.2 and 73.5 percent, respectively).

Mastitis treatment protocols vary by herd size, region, and the type of operation (conventional versus organic). Since mastitis is primarily caused by a bacterial infection of the udder, antimicrobials are commonly used for treatment. Overall, 96.9 percent of operations used an antimicrobial in their treatment protocols/procedures; the highest percentage of operations (89.4 percent) used IMM antimicrobials. Frequent stripping

of the affected quarter or early dry-off was included in some treatment protocols for 61.3 and 50.0 percent of operations, respectively. The majority of cows identified with clinical mastitis (87.3 percent) were treated with antimicrobials. Nearly three-fourths of operations (73.0 percent) used cephalosporins as their primary antimicrobials for treating mastitis; 34.4 percent used first generation cephalosporins, and 38.6 percent used third generation cephalosporins.

Of the 21.4 percent of cows affected with and treated for mastitis with antimicrobials, 50.7 percent were given third generation cephalosporins, 24.7 percent were given lincosamide, and 15.2 percent were given first generation cephalosporins as a primary treatment for mastitis. Lincosamide was the primary antimicrobial for mastitis treatment on only 7.0 percent of all operations; however, these operations represented 24.7 percent of all cows treated.

There are seven IMM products approved for use in lactating cows in the United States. Of operations that treated cows with IMM products, 34.4 percent primarily used SPECTRAMAST® LC, a third generation cephalosporin, and about one-third (32.2 percent) used Today®/Cefa-Lak, a first generation cephalosporin. For operations that used IMM antimicrobials, about 90 percent across herd sizes and regions used historical observations of effectiveness as the criterion to select the antimicrobial used.

Producers estimated that, on average, the direct cost to treat a single case of mastitis was $42.05. This amount was similar across herd sizes and regions. IMM antimicrobials accounted for the single highest cost at $13.79 per mastitis case.

Dry-off procedures

Producers have options when drying off lactating cows. One option is to dry cows off based on a set dry period, which is usually 60 days before an expected calving date and is termed a “set schedule.” Alternatively, cows that do not maintain an operation’s minimum milk production level before reaching a set schedule are dried off based on low production. Almost all operations (98.8 percent) dried at least some cows off on a set schedule, while more than four-fifths (81.3 percent) also dried some cows off based on a minimum milk production level. The majority of cows (89.8 percent) were dried off on a set schedule, while only 10.2 percent of cows were dried off based on the cows’ milk production level.

IMM antibiotics are routinely administered at dry-off to treat existing infections and prevent development of new infections early in the dry period. Blanket therapy (treating all cows with IMM antimicrobial drugs at dry-off) is thought to be more effective than selective dry-cow therapy (treating specific cows based on farm-level criteria). Approximately 10 percent of all operations (9.2 percent) did not use IMM antimicrobials at dry-off, but 93.0 percent of cows were treated with dry-cow IMM antimicrobials. The

majority of operations that dry-treated cows with IMM antimicrobials (58.1 percent) administered Cefa-Dri/Tomorrow. About one-fourth of operations administered SPECTRAMAST DC or Quartermaster® (27.9 and 24.5 percent, respectively).

Teat sealants provide an additional physical barrier that helps prevent bacteria from entering the teat and causing mastitis. There are internal and external teat sealants, which can be used concurrently at dry-off. Overall, 36.9 percent of all operations used an internal teat sealant on at least some cows, and 33.9 percent of operations used an internal teat sealant on all cows at dry-off. Overall, 14.0 percent of operations used an external teat sealant.

Residue testing and prevention

Every tanker load of milk in the United States is tested for beta-lactam residues before processing at the milk plant. The presence of beta-lactam residues in milk has declined over the last decade. In 2015, residues were detected in only 0.012 percent of tanker loads tested. Consequences of a positive test include discarding the entire truckload of milk and the possible suspension of the producer's permit to sell milk. Milk from cows treated with antimicrobials should be discarded for a specified withdrawal period, as directed by the manufacturer's product label. More than 90 percent of operations administered drugs—not limited to antimicrobials—that required a milk withdrawal period or a milk and meat withdrawal period.

Testing milk on-farm for antimicrobial residues is frequently used to evaluate milk from individually treated cows or to screen the bulk tank before milk is shipped. Overall, 70.8 percent of operations did some on-farm testing of milk for antimicrobial residues. Of operations that tested milk on-farm for antimicrobial residues, the highest percentage (89.7 percent) tested individual cows that had been recently treated with antimicrobials. Slightly over half of operations tested fresh cows or bulk-tank milk before processor pickup.

Producers should keep records on all animals treated with drugs that require a withdrawal period for milk or meat. One of the most important methods of ensuring that milk from treated cows does not enter the bulk tank is to mark treated cows so that milkers can identify these cows and exclude their milk from the bulk tank.

On operations that administered any drugs that required a withdrawal period for milk or meat, the majority of medium, large, and all operations (76.7, 71.0, and 59.5 percent, respectively), used leg bands to identify treated cows. Treated cows were not marked on 11.9 percent of operations, but almost one-fourth of operations (23.0 percent) housed treated lactating cows separately from nontreated cows.

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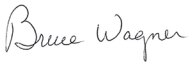

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Feedback

Feedback, comments, and suggestions regarding Dairy 2014 study reports are welcomed. You may submit feedback via online survey at: http://www.aphis.usda.gov/nahms (Click on “FEEDBACK on NAHMS reports.”)

For questions about this report or additional copies, please contact:

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Introduction

The National Animal Health Monitoring System (NAHMS) is a nonregulatory program of the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service. NAHMS is designed to help meet the Nation's animal-health information needs and has collected data on dairy health and management practices through four previous studies:

The 1991–92 National Dairy Heifer Evaluation Project (NDHEP) provided the dairy industry's first national information on the health and management of dairy cattle in the United States. Just months after the study's first results were released in 1993, cases of acute bovine viral diarrhea surfaced in the United States following a 1993 outbreak in Canada. Information from NDHEP on vaccination and biosecurity practices helped officials address the risk of disease spread and target educational efforts on vaccination protocols. In addition, an outbreak of human illness was reported in 1993 in the Pacific Northwest, this time related to *Escherichia coli* 0157:H7. NDHEP data on the prevalence to *Escherichia coli* 0157:H7 in dairy cattle helped officials define public risks as well as research needs. This baseline picture of the industry also helped identify additional research and educational efforts in various production areas, such as feed management and weaning age.

The Dairy 1996 study helped the U.S. dairy industry identify educational needs and prioritize research efforts on such timely topics as antimicrobial usage and Johne's disease, as well as digital dermatitis, bovine leukosis virus, and potential foodborne pathogens, including *E. coli*, *Salmonella*, and *Campylobacter*.

The Dairy 2002 study described management strategies that prevent and reduce Johne's disease and determined management factors associated with *Mycoplasma* and *Listeria* in bulk-tank milk. Additionally, levels of participation in quality assurance programs, the incidence of digital dermatitis, a profile of animal-waste handling systems used on U.S. dairy operations, and changes in the industry since the NDHEP 1991 and Dairy 1996 studies were examined in Dairy 2002.

The Dairy 2007 study evaluated cow comfort using an on-farm assessment tool, evaluated passive transfer and growth of preweaned heifer calves, and estimated the prevalence of multiple diseases, including bovine viral diarrhea virus, contagious mastitis pathogens, *Mycobacterium avium* spp. *paratuberculosis*, and food safety pathogens such as *Salmonella* and *Listeria*. The implementation of biosecurity practices was also evaluated, as has been done in every NAHMS dairy study. Additionally, industry changes since the NDHEP, Dairy 1996, and Dairy 2002 studies were examined.

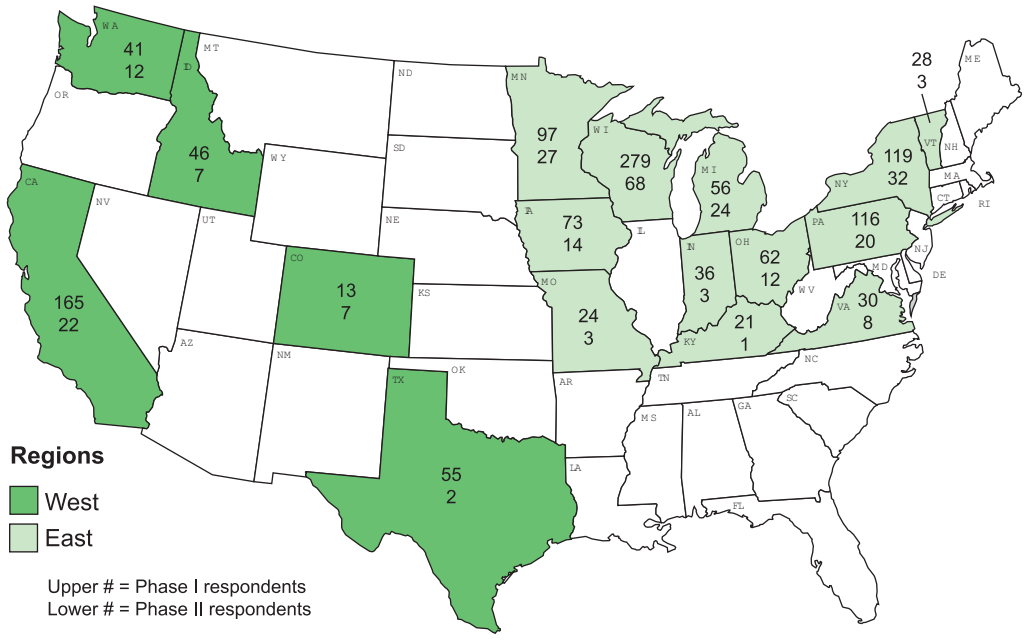
The latest NAHMS dairy study, Dairy 2014, was conducted in 17 of the Nation's major dairy States (see map) and provides valuable information to participants, stakeholders,

and the industry as a whole. Data in the study represent 80.5 percent of U.S. dairy operations and 81.3 percent of U.S. dairy cows. Results are presented in a variety of publications, including the following reports:

- “Dairy Cattle Management Practices in the United States 2014” contains national information collected from 1,261 dairy operations participating in the NAHMS Dairy 2014 study.
- “Milk Quality, Milking Procedures, and Mastitis on U.S. Dairy Operations, 2014,” is the second in a series of reports from the NAHMS Dairy 2014 study. The majority of this report presents national information from 265 operations with 30 or more dairy cows; these 265 operations are a subset of the 1,261 operations described in the NAHMS report “Dairy Cattle Management Practices in the United States 2014.” State and Federal veterinary medical officers and animal health technicians conducted questionnaire interviews with producers and collected biological samples for analysis from March 6 through July 28, 2014.

All NAHMS Dairy reports are available at: http://www.aphis.usda.gov/nahms

NAHMS Dairy 2014 Participating States



Methods used, definitions for phase I and phase II of the study, and the number of respondents can be found in the Methodology section of this report on page 85.

Terms Used in This Report

Annual milk production: The total amount of milk produced during the year by all cows on an operation.

Antibiotics: Substances produced by microorganisms that kill or inhibit the growth of other microorganisms.

Antimicrobial: Any substances, including antibiotics, that kill or inhibit the growth of microorganisms.

California Mastitis Test (CMT): An indirect test of bovine mastitis that measures leukocyte counts in milk.

Cow: Female dairy bovine that has calved at least once.

Cow average: The average value for all cows; the reported value for each operation multiplied by the number of cows on that operation is summed over all operations and divided by the number of cows on all operations. This way, results are adjusted for the number of cows on each operation. For instance, on page 12, the rolling herd average milk production (lb/cow) is multiplied by the number of cows on each operation. This product is then summed over all operations and divided by the sum of cows on all operations. The result is the weighted operation average rolling herd average milk production for all cows.

CWT: Refers to hundredweight of milk (100 lb).

Dry-off: The cessation of lactation. This is the time when IMM antimicrobials and/or teat sealants are commonly administered.

Dry period: The period from the end of one lactation to the beginning of a new lactation. A 60-day dry period is commonly recommended.

Fresh cow: A cow that has given birth within the last few days or weeks.

Heifer: Female dairy bovine that has not yet calved.

Herd size: Herd size is based on an operation's January 1, 2014, dairy cow inventory. Very small operations had fewer than 30 head; small operations had 30 to 99 head; medium operations had 100 to 499 head; and large operations had 500 or more head. Very small operations were administered an abbreviated questionnaire with a subset of the questions administered to operations with 30 or more cows.

Mastitis: Inflammation of the mammary gland most commonly caused by a bacterial infection.

Milking facilities:

Tie stall/stanchion barns: Portable milking equipment is moved between cows.

Parlors: Fixed milking equipment and the cows move to the milking equipment.

Operation: Premises with at least one dairy cow on January 1, 2014.

Operation average: The average value for all operations. A single value for each operation is summed over all operations reporting divided by the number of operations reporting. For example, the operation average bulk-tank somatic cell count (BTSCC) during 2013 (p 8) was calculated by summing reported average BTSCCs for each operation divided by the number of operations.

Operation type:

Conventional: An operation in which the majority of forage consumed is not harvested by cows.

Combination: An operation that uses both conventional and grazing practices.

Grazing: An operation in which the majority of forage consumed is harvested by cows during the growing season.

Organic: A farm that meets USDA organic standards.

Parlor type:

Flat barn: Similar to tie stall or stanchion barn, except the milking equipment is permanently mounted and the cows move to the milking equipment.

Herringbone (fishbone): Elevated platform on which the cows face away from the milking pit at an angle (~35^{o}). Cows on one side of the parlor exit at the same time.

Parabone: A hybrid of a herringbone and parallel parlor. The stall width is similar to a parallel parlor but cows are at more of an angle (~65^{o}) to the milking pit than a herringbone parlor.

Parallel (side by side): Elevated platform on which the cows face away from the milking pit and the milking units are applied by going between the back legs. Cows on one side of the parlor exit at the same time.

Rotary (carousel): Elevated platform that moves in a circle similar to a carousel. Cows enter and exit the platform one at a time.

Side opening (tandem): Parlors with milking stalls that may be angled away from the milking pit similar to a herringbone, with the advantage that cows are released individually instead of waiting for the entire side to finish milking.

Swing: Usually a parabone-type configuration with the milking units in the center of the milking pit, allowing for only one side of the parlor to be milked at a time.

Population estimates: Estimates in this report are provided with a measure of precision called the standard error. A 95-percent confidence interval can be created with bounds equal to the estimate plus or minus two standard errors. If the only error is sampling error, the confidence intervals created in this manner will contain the true population mean 95 out of 100 times. An estimate of 7.5 with a standard error of 1.0 results in limits of 5.5 to 9.5 (two times the standard error above and below the estimate). An estimate of 3.4 with a standard error of 0.3 results in limits of 2.8 and 4.0. Alternatively, the 90-percent confidence interval would be created by multiplying the standard error by 1.65 instead of 2. Most estimates in this report are rounded to the nearest tenth. If rounded to 0, the standard error was reported as (0.0). If there were no reports of the event, no standard error was reported (—).

Regions:

West: California, Colorado, Idaho, Texas, Washington.
East: Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, Wisconsin.

Rolling herd average (RHA) milk production: The average amount of milk produced per cow, per year (or per lactation) on an operation.

Sample profile: Information that describes characteristics of the operations from which Dairy 2014 data were collected.

Somatic cell count (SCC): The number of white blood cells and secretory cells per milliliter of raw milk, used as an indicator of milk quality. When used in referring to the SCC of bulk-tank milk instead of milk from individual cows, it is commonly abbreviated as BTSCC.

Section I: Population Estimates

Note: Data in all tables refer to calendar year 2013, unless otherwise noted.

Note: Where applicable, column or row totals are shown as 100.0 to aid in interpretation; however, estimates may not always sum to 100.0 due to rounding.

A. Bulk-tank Somatic Cell Count

Bulk-tank somatic cell count (BTSCC) refers to the number of white blood cells and secretory cells per milliliter of raw milk and is used as an indicator of milk quality. The current legal limit in the United States is 750,000 cells/mL, but the national average is less than 200,000 cells/mL. The majority of operations, regardless of herd size or region, had average BTSCCs from 100,000 to 299,000 cells/mL. A higher percentage of operations in the West region (75.4 percent) had average BTSCCs of less than 200,000 cells/mL than the East region (49.6 percent).

A.1.a. Percentage of operations by average BTSCC of milk shipped, and by herd size and region:

Percent Operations

	Herd size (number of cows)											
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**Region** **West**		**Region** **East**		**All operations**	
BTSCC (cells/mL x1,000)	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Less than 100	4.3	(2.3)	3.3	(1.7)	2.3	(1.1)	0.0	(—)	4.1	(1.5)	3.7	(1.3)
100 to 199	41.5	(6.5)	51.5	(6.4)	63.6	(5.5)	75.4	(6.8)	45.5	(4.3)	48.6	(4.0)
200 to 299	27.1	(5.5)	30.5	(5.9)	29.8	(5.3)	19.8	(6.3)	29.7	(3.8)	28.7	(3.5)
300 to 399	23.2	(5.6)	12.5	(4.2)	3.8	(1.7)	4.8	(3.0)	17.7	(3.6)	16.4	(3.2)
400 to 499	3.8	(2.3)	2.1	(2.1)	0.5	(0.5)	0.0	(—)	3.0	(1.5)	2.7	(1.3)
500 or more	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

The mean BTSCC for all operations was 206,500 cells/mL, which is similar to the count reported for the United States based on data from the Federal Milk Marketing Orders. Although the mean BTSCC decreased as herd size increased, the decrease was not significant.

A.1.b. Operation average minimum, mean, and maximum BTSCCs for milk shipped, by herd size and by region:

Operation Average BTSCC (x1,000)

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
BTSCC parameter	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
Minimum	123.0	(6.5)	126.5	(7.9)	125.3	(5.0)	110.7	(7.4)	126.1	(4.6)	124.5	(4.2)
Mean	217.7	(11.8)	202.4	(9.1)	182.1	(6.0)	171.9	(8.3)	210.6	(7.4)	206.5	(6.8)
Maximum	414.5	(24.5)	329.4	(23.7)	265.1	(11.3)	262.8	(17.3)	373.1	(16.3)	361.7	(14.9)

B. Milking Facilities and Equipment

1. Milking facilities

There are two primary types of milking facilities: one in which milking equipment is moved to cows, such as a tie stall or stanchion barn, and one in which cows are moved to the equipment, such as a parlor. A slightly higher percentage of all operations milked cows in a tie stall or stanchion barn than in a parlor (52.6 and 45.8 percent, respectively). Milking facilities for very small and small operations were similar, with nearly three-fourths using tie stalls or stanchion barns. Parlors were used to milk cows on 79.4 percent of medium operations and on 99.8 percent of large operations. Robotic milking facilities are reflected in the “Other” category.

B.1.a. Percentage of operations by primary milking facility used, and by herd size:

Percent Operations

Herd Size (number of cows)

	Very small (fewer than 30)		**Small** (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Primary facility	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Parlor	17.7	(5.2)	27.3	(2.1)	79.4	(2.4)	99.8	(0.2)	45.8	(1.5)
Tie stall or stanchion barn	73.7	(5.9)	72.7	(2.1)	19.3	(2.3)	0.2	(0.2)	52.6	(1.5)
Other	8.6	(3.5)	0.0	(—)	1.3	(0.6)	0.0	(—)	1.6	(0.5)
Total	100.0		100.0		100.0		100.0		100.0	

Overall, 86.6 percent of cows were milked in a parlor and 13.1 percent were milked in a tie stall or stanchion barn. The majority of cows on very small and small operations were milked in a tie stall or stanchion barn, while the majority of cows on medium and large operations were milked in a parlor.

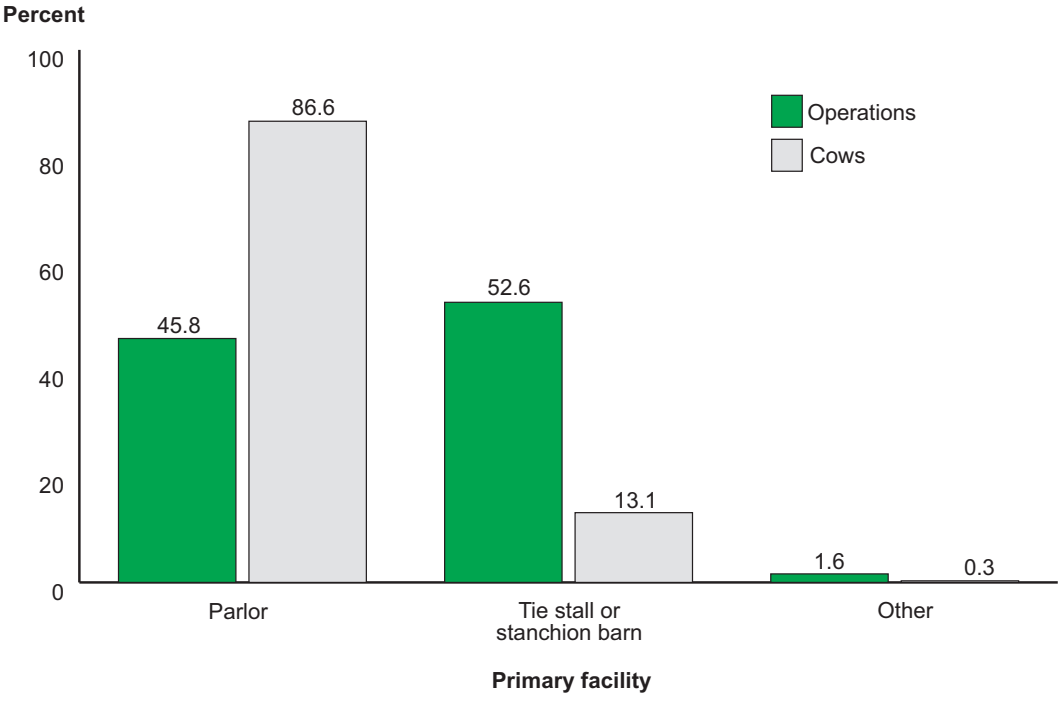
B.1.b. Percentage of cows by primary milking facility used, and by herd size:

Percent Cows

Herd Size (number of cows)

	Very small (fewer than 30)		**Small** (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Primary facility	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Parlor	25.7	(8.1)	29.5	(2.2)	85.8	(1.8)	99.9	(0.1)	86.6	(0.6)
Tie stall or stanchion barn	73.1	(8.1)	70.5	(2.2)	13.1	(1.7)	0.1	(0.1)	13.1	(0.6)
Other	1.2	(0.6)	0.0	(—)	1.1	(0.5)	0.0	(—)	0.3	(0.1)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of operations and percentage of cows by primary milking facility used



More than 90 percent of operations in the West region (92.2 percent) primarily milked cows in a parlor, while the majority of operations in the East region (56.8 percent) primarily milked cows in a tie stall or stanchion barn.

B.1.c. Percentage of operations by primary milking facility used, and by region:

	Percent Operations			
	Region			
	West		East	
Primary facility	**Percent**	**Std. error**	**Percent**	**Std. error**
Parlor	92.2	(3.2)	41.6	(1.6)
Tie stall or stanchion barn	6.6	(3.0)	56.8	(1.6)
Other	1.2	(1.2)	1.6	(0.6)
Total	100.0		100.0	

Nearly all cows in the West region (99.7 percent) and more than three-fourths of cows in the East region (76.8 percent) were primarily milked in a parlor.

B.1.d. Percentage of cows by primary milking facility used, and by region:

	Percent Cows			
	Region			
	West		East	
Primary facility	**Percent**	**Std. error**	**Percent**	**Std. error**
Parlor	99.7	(0.2)	76.8	(1.1)
Tie stall or stanchion barn	0.3	(0.2)	22.7	(1.0)
Other	0.0	(—)	0.4	(0.2)
Total	100.0		100.0	

The operation average rolling herd average (RHA) milk production increased from small to large operations, regardless of type of primary milking facility.

B.1.e. Operation average RHA milk production (lb/cow), by primary milking facility and by herd size:

Operation Average RHA Milk Production (lb/cow)

Herd Size (number of cows)

	Very small (fewer than 30)		**Small** (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Primary facility	**lb/ cow**	**Std. error**	**lb/ cow**	**Std. error**	**lb/ cow**	**Std. error**	**lb/ cow**	**Std. error**	**lb/ cow**	**Std. error**
Parlor	18,725	(1,957)	18,329	(445)	21,891	(287)	25,276	(154)	21,417	(224)
Tie stall or stanchion barn	14,608	(849)	19,233	(300)	20,884	(495)	*		18,597	(283)
Any	15,405	(792)	18,990	(248)	21,706	(247)	25,273	(153)	19,932	(183)

*Too few to report.

As expected, as herd size increased so did the operation average annual milk production. The amount of milk annually produced by operations that used a parlor as their primary milking facility was about seven times the amount produced by operations that primarily used a tie stall or stanchion barn (104,491 and 14,296 cwt, respectively). This finding highlights the fact that almost three-fourths of cows on operations with fewer than 100 head were milked in a tie stall or stanchion, and almost all cows on operations with 500 or more cows were milked in a parlor (table B.1.b).

B.1.f. Operation average annual milk production (cwt), by primary milking facility used and by herd size:

Operation Average Annual Milk Production (cwt)

Herd Size (number of cows)

	Very small (fewer than 30)		**Small** (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Primary facility	**CWT**	**Std. error**	**CWT**	**Std. error**	**CWT**	**Std. error**	**CWT**	**Std. error**	**CWT**	**Std. error**
Parlor	4,050	(1,106)	20,654	(8,988)	50,307	(9,459)	353,399	(20,493)	104,491	(7,214)
Tie stall or stanchion barn	3,812	(1,286)	15,799	(4,096)	22,907	(1,185)	*		14,296	(2,983)
Any	3,553	(976)	17,082	(3,843)	44,974	(7,495)	352,858	(20,438)	55,956	(3,585)

*Too few to report.

Herringbone and parallel parlors were the primary parlor types used by the highest percentages of operations (45.7 and 29.9 percent, respectively). The use of herringbone parlors decreased as herd size increased, while the use of parallel and rotary parlors increased as herd size increased.

B.1.g. For the 45.8 percent of operations that used a milking parlor (table B.1.a), percentage of operations by primary milking parlor used and by herd size:

Percent Operations

Herd Size (number of cows)

	Small (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Primary parlor	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Herringbone (fishbone)	53.9	(4.6)	46.6	(3.0)	31.8	(2.1)	45.7	(2.1)
Parallel (side by side)	20.2	(3.8)	28.5	(2.7)	46.9	(2.3)	29.9	(1.8)
Parabone	7.5	(2.4)	9.4	(1.7)	6.1	(1.3)	8.0	(1.1)
Flat barn	8.5	(2.9)	5.7	(1.3)	5.7	(1.1)	6.6	(1.1)
Side opening (tandem)	7.5	(2.3)	2.5	(1.0)	1.1	(0.4)	3.8	(0.9)
Swing	1.2	(0.9)	5.0	(1.4)	0.4	(0.3)	2.8	(0.7)
Rotary (carousel)	0.0	(—)	0.9	(0.6)	7.0	(1.1)	2.0	(0.4)
Other	1.2	(0.7)	1.3	(0.6)	1.1	(0.4)	1.3	(0.4)
Total	100.0		100.0		100.0		100.0	

Of the 86.6 percent of cows milked in a parlor, the highest percentages were either milked in a herringbone parlor or a parallel parlor (30.7 and 44.7 percent of cows, respectively). On large operations, rotary parlors were used to milk 14.1 percent of cows; only 7.0 percent of large operations used rotary parlors, suggesting that operations with inventories considerably larger than 500 cows used rotary parlors.

B.1.h. For the 86.6 percent of cows milked in a parlor (table B.1.b), percentage of cows by primary milking parlor used and by herd size:

Percent Cows

Herd Size (number of cows)

	Small (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Primary parlor	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Herringbone (fishbone)	55.5	(4.8)	45.3	(3.2)	25.1	(2.2)	30.7	(1.9)
Parallel (side by side)	20.3	(4.1)	32.7	(3.1)	49.5	(2.9)	44.7	(2.3)
Parabone	7.8	(2.5)	7.5	(1.5)	4.9	(1.1)	5.6	(0.9)
Flat barn	7.3	(2.7)	6.2	(1.5)	3.1	(0.7)	4.0	(0.6)
Side opening (tandem)	6.4	(2.0)	1.9	(0.8)	0.6	(0.2)	1.1	(0.3)
Swing	1.1	(0.8)	4.3	(1.3)	0.3	(0.2)	1.2	(0.3)
Rotary (carousel)	0.0	(—)	1.0	(0.7)	14.1	(2.6)	10.7	(2.0)
Other	1.6	(1.0)	1.1	(0.5)	2.5	(1.5)	2.1	(1.1)
Total	100.0		100.0		100.0		100.0	

Rotary (carousel) milking parlors were used by a slightly higher percentage of operations in the West region than in the East region; otherwise, there were no regional differences.

B.1.i. For the 45.8 percent of operations that used a milking parlor (table B.1.a), percentage of operations by primary milking parlor used and by region:

	Percent Operations			
	Region			
	West		East	
Primary parlor	**Percent**	**Std. error**	**Percent**	**Std. error**
Herringbone (fishbone)	41.0	(3.5)	46.6	(2.4)
Parallel (side by side)	33.3	(3.1)	29.2	(2.1)
Parabone	4.6	(1.2)	8.8	(1.4)
Flat barn	10.5	(1.9)	5.8	(1.3)
Side opening (tandem)	3.3	(1.9)	3.9	(1.0)
Swing	0.9	(0.7)	3.2	(0.9)
Rotary (carousel)	5.0	(1.0)	1.3	(0.4)
Other	1.4	(0.6)	1.2	(0.5)
Total	100.0		100.0	

There were no regional differences in the percentages of cows by type of primary milking parlor used. While only 1.3 percent of parlor operations in the East region primarily used a rotary parlor (table B.1.i), 10.2 percent of cows in the East region were milked in a rotary parlor.

B.1.j. For the 86.6 percent of cows milked in a parlor (table B.1.b), percentage of cows by primary milking parlor used and by region:

	Percent Cows			
	Region			
	West		East	
Primary parlor	**Percent**	**Std. error**	**Percent**	**Std. error**
Herringbone (fishbone)	28.4	(2.9)	33.0	(2.3)
Parallel (side by side)	46.2	(3.6)	43.1	(2.8)
Parabone	5.2	(1.4)	5.9	(1.0)
Flat barn	4.9	(1.0)	3.1	(0.7)
Side opening (tandem)	0.9	(0.4)	1.3	(0.3)
Swing	0.3	(0.2)	2.0	(0.6)
Rotary (carousel)	11.2	(2.8)	10.2	(2.8)
Other	2.9	(2.1)	1.3	(0.7)
Total	100.0		100.0	

2. Equipment

Automatic takeoffs (or detachers) are designed to remove milking clusters from the teats once milk flow declines to a specified level. Using properly adjusted and maintained takeoffs prevents overmilking and maintains optimum teat-end condition.

Almost half of all operations (49.1 percent) used automatic takeoffs. Almost all large operations (93.5 percent) used automatic takeoffs, while only 19.9 percent of small operations used them. Nearly double the percentage of operations in the West region than in the East region used automatic takeoffs (83.6 and 45.1 percent, respectively).

B.2.a. Percentage of operations that used automatic takeoffs, by herd size and by region:

Percent Operations

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
19.9	(5.0)	74.1	(6.0)	93.5	(2.6)	83.6	(5.5)	45.1	(4.1)	49.1	(3.8)

Backflush systems are designed to remove residual milk from milking clusters and are primarily used to reduce exposure to contagious mastitis pathogens. Only 6.0 percent of operations used a backflush system. There were no differences by herd size or by region in the use of backflush systems.

B.2.b. Percentage of operations that used a backflush system, by herd size by and region:

Percent Operations

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
5.0	(3.0)	4.2	(1.9)	12.1	(2.6)	12.9	(3.3)	5.2	(1.9)	6.0	(1.7)

Backflush systems disinfect milking liners, which can help reduce the potential of transmitting contagious mastitis pathogens from one cow to another via milk residues on the liners.

Overall, 93.3 percent of the 6.0 percent of operations that used a backflush system did so for every milking. About two-thirds of these operations (67.7 percent) used an automatic backflush system, while one-third used a manual backflush system. The percentages of operations that used an automatic backflush system or a manual system were similar by region and by herd size (not shown).

B.2.c. For the 6.0 percent of operations that used a backflush system (table B.2.b), percentage of operations by use of a backflush system, and by region:

	Percent Operations					
	Region					
	West		East		All operations	
Use	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error
For every milking	100.0	(—)	91.6	(6.5)	93.3	(5.0)
Automatic	78.7	(11.1)	64.7	(16.0)	67.7	(12.5)
Manual	21.3	(11.1)	35.3	(16.0)	32.3	(12.5)
Total	100.0		100.0		100.0	

Overall, 18.3 percent of all operations used computer technology to record daily milk weights. The use of computer technology to record milk weights increased as herd size increased, at both the operation level and the cow level. Also, a higher percentage of operations in the West region used computer technology compared with the East region. Overall, 46.1 percent of cows were on operations that used computer technology to record milk weights.

B.2.d. Percentage of operations and percentage of cows on those operations in which computer technology was used to record daily milk weights for individual cows, by herd size and by region:

Percent

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Parameter	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Operations	6.8	(1.3)	26.4	(2.4)	59.3	(2.3)	46.4	(2.5)	15.6	(1.1)	18.3	(1.1)
Cows	8.2	(1.6)	30.3	(2.8)	59.1	(2.9)	57.5	(3.5)	37.4	(2.2)	46.1	(1.9)

C. Milking Procedures

1. Personnel and training

Standardized and consistently applied milking procedures increase parlor efficiency by providing cows with a routine that promotes effective and consistent milk let down and flow. Proper training of milking personnel is paramount in achieving consistent milking procedures.

On almost half of operations (47.2 percent), owners or operators milked the majority of cows. On 65.9 percent of small operations, the operation owner or operator milked the majority of cows, while on 99.1 percent of large operations hired workers milked the majority of cows. Operations in the West region tend to be larger than those in the East region, which might account for the regional differences in who milked the majority of cows on the operation. In the West region, hired workers milked the majority of cows on 93.4 percent of operations, while in the East region owners/operators milked the majority of cows on 51.8 percent of operations.

C.1.a. Percentage of operations by personnel that milked the majority of cows on the operation, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Personnel	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Owner/ operator	65.9	(6.4)	41.7	(6.6)	0.9	(0.9)	6.6	(4.1)	51.8	(4.3)	47.2	(4.0)
Family member(s) of owner	29.5	(6.2)	21.7	(5.1)	0.0	(—)	0.0	(—)	24.5	(4.1)	22.0	(3.7)
Hired worker(s) (nonfamily member)	4.6	(2.3)	36.6	(5.8)	99.1	(0.9)	93.4	(4.1)	23.8	(2.7)	30.8	(2.9)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

The highest percentage of cows on small operations (61.6 percent) were on operations in which the majority of cows were milked by the owner or operator, while almost all cows on large operations (99.7 percent) were milked by hired workers. Nearly all cows in the West region (99.7 percent) and more than 70 percent of cows in the East region (70.6) were milked by hired workers. More than 80 percent of all cows (83.7 percent) were milked by hired workers.

C.1.b. Percentage of cows on operations in which the majority of cows were milked by the specified personnel, by herd size and by region:

Percent Cows

	Herd size (number of cows)					
	Small (30–99)	**Medium** (100–499)	**Large** (500+)	**Region**		**All operations**
				West	**East**	
Personnel	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**
Owner/ operator	61.6 (6.7)	32.1 (5.8)	0.3 (0.3)	0.3 (0.2)	18.9 (2.7)	10.5 (1.5)
Family member(s) of owner	31.9 (6.4)	19.8 (5.0)	0.0 (—)	0.0 (—)	10.5 (2.1)	5.8 (1.1)
Hired worker(s) (nonfamily member)	6.5 (3.2)	48.2 (6.1)	99.7 (0.3)	99.7 (0.2)	70.6 (3.5)	83.7 (1.9)
Total	100.0	100.0	100.0	100.0	100.0	100.0

The percentage of operations that trained milkers on proper milking procedures increased as herd size increased. Overall, 59.8 percent of operations trained milkers. A higher percentage of operations in the West region than in the East region trained milkers (87.9 and 56.6 percent, respectively). The highest percentages of operations only trained milkers when they were new employees (28.1 percent) or trained all milkers one to two times per year (17.8 percent).

C.1.c. Percentage of operations by how frequently milkers were trained on milking procedures, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Frequency	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Trained new personnel only	21.6	(5.1)	40.6	(6.0)	25.8	(4.6)	36.2	(8.5)	27.2	(3.6)	28.1	(3.3)
1 to 2 times per year for all milkers	15.1	(4.8)	15.7	(4.3)	29.2	(5.3)	22.1	(6.2)	17.3	(3.2)	17.8	(3.0)
3 to 4 times per year for all milkers	0.0	(—)	2.3	(1.6)	15.4	(5.0)	12.6	(7.6)	2.4	(0.7)	3.4	(1.1)
More than 4 times per year for all milkers	5.9	(3.5)	0.9	(0.9)	21.3	(5.0)	11.7	(5.1)	6.6	(2.2)	7.1	(2.1)
Other	3.5	(1.8)	4.2	(2.1)	2.0	(1.6)	5.2	(3.6)	3.2	(1.3)	3.4	(1.2)
Any	46.1	(6.4)	63.7	(6.4)	93.7	(2.8)	87.9	(5.1)	56.6	(4.3)	59.8	(4.0)
None	53.9	(6.4)	36.3	(6.4)	6.3	(2.8)	12.1	(5.1)	43.4	(4.3)	40.2	(4.0)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

On operations that conducted milker training, the owner was the primary person responsible for training on 62.0 percent of operations. The owner was responsible for training on a higher percentage of small and medium operations (81.3 and 73.5 percent, respectively) compared with large operations (21.9 percent). The owner was the primary person responsible for training milkers on a higher percentage of operations in the East region than in the West region (66.4 and 36.8 percent, respectively). Training conducted by a manager/herdsman increased as herd size increased.

C.1.d. For the 59.8 percent of operations that trained milkers (table C.1.c), percentage of operations by primary personnel responsible for training milkers, and by herd size and region:

Percent Operations

	Herd size (number of cows)					
	Small (30–99)	**Medium** (100–499)	**Large** (500+)	**West**	**East**	**All operations**
Primary personnel	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**	**Pct. Std. error**
Owner	81.3 (8.9)	73.5 (6.5)	21.9 (5.1)	36.8 (9.5)	66.4 (4.9)	62.0 (4.5)
Manager/ herdsman	3.0 (3.0)	11.8 (4.2)	47.9 (6.1)	37.3 (8.7)	15.3 (3.0)	18.6 (2.9)
Other employees	13.7 (8.7)	11.5 (5.2)	21.6 (5.1)	18.6 (9.0)	14.6 (4.4)	15.2 (4.0)
Veterinarian	0.0 (—)	1.8 (1.8)	3.4 (2.0)	3.3 (3.2)	1.3 (0.8)	1.6 (0.8)
University/ extension personnel	1.9 (1.9)	0.0 (—)	0.0 (—)	0.0 (—)	0.9 (0.8)	0.7 (0.7)
Other	0.0 (—)	1.5 (1.4)	5.2 (1.9)	4.1 (2.2)	1.6 (0.7)	2.0 (0.7)
Total	100.0	100.0	100.0	100.0	100.0	100.0

On-the-job training was used on more than 90 percent of operations that trained milkers. Higher percentages of large operations used video/Web-based training or discussion/ lecture than did small or medium operations. This finding was also true for operations in the West region compared with operations in the East region.

C.1.e. For the 59.8 percent of operations that trained milkers (table C.1.c), percentage of operations by milker-training methods used on the operation, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Method	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Video/Web-based training	3.2	(3.1)	4.1	(2.9)	33.5	(5.5)	29.7	(7.7)	8.8	(2.2)	12.0	(2.3)
Discussion/ lecture	19.6	(6.6)	34.3	(7.0)	78.1	(4.6)	64.9	(9.1)	36.3	(4.7)	40.7	(4.4)
On-the-job training	98.3	(1.7)	98.7	(1.3)	93.7	(2.6)	91.2	(4.9)	98.2	(0.9)	97.1	(1.1)

2. Milking frequency

Increasing milking frequency can increase overall milk production. A total of 88.4 percent of operations milked the majority of cows two times per day. More than 80 percent of very small, small, and medium operations milked the majority of cows two times per day. The majority of large operations (56.8 percent) milked cows three times per day.

C.2.a. Percentage of operations by number of times per day the majority of cows were milked, and by herd size:

Percent Operations

Herd Size (number of cows)

	Very small (fewer than 30)		**Small** (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Times per day	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
1	8.4	(3.9)	0.1	(0.1)	0.2	(0.2)	0.0	(—)	1.3	(0.6)
2	91.6	(3.9)	97.9	(0.7)	84.4	(1.9)	43.0	(1.9)	88.4	(0.9)
3	0.0	(—)	2.0	(0.7)	15.1	(1.9)	56.8	(1.9)	10.2	(0.7)
More than 3	0.0	(—)	0.0	(—)	0.2	(0.2)	0.2	(0.2)	0.1	(0.1)
Total	100.0		100.0		100.0		100.0		100.0	

A higher percentage of operations in the East region than in the West region (89.4 and 77.9 percent, respectively) milked cows two times per day, and a higher percentage of operations in the West region than in the East region (18.8 and 9.4 percent, respectively) milked cows three times per day.

C.2.b. Percentage of operations by number of times per day the majority of cows were milked, and by region:

	Percent Operations			
	Region			
	West		East	
Times per day	Percent	Std. error	Percent	Std. error
1	3.0	(2.1)	1.2	(0.6)
2	77.9	(2.6)	89.4	(0.9)
3	18.8	(1.9)	9.4	(0.7)
More than 3	0.2	(0.2)	0.1	(0.1)
Total	100.0		100.0	

Glove use by milking personnel decreases the risk of transmitting pathogens between cows. To be effective, gloves must be cleaned or changed once they become contaminated. The percentage of operations in which milkers always used gloves increased as herd size increased (46.8 percent of small operations to 95.9 percent of large operations). Milkers on a higher percentage of operations in the West region than in the East region always wore gloves (85.5 percent and 56.1 percent, respectively). Milkers on 59.1 percent of all operations always wore gloves while milking, while milkers on one-fourth of operations (24.5 percent) never wore gloves.

C.2.c. Percentage of operations by how often milkers wore latex or nitrile gloves when milking cows, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Frequency	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Always	46.8	(6.5)	59.2	(6.4)	95.9	(2.4)	85.5	(5.5)	56.1	(4.5)	59.1	(4.1)
Sometimes	14.6	(5.1)	26.7	(6.2)	4.1	(2.4)	12.4	(5.2)	16.9	(3.6)	16.4	(3.3)
Never	38.6	(6.3)	14.1	(4.3)	0.0	(—)	2.1	(2.0)	27.1	(4.1)	24.5	(3.7)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

Overall, 87.9 percent of cows were on operations in which milkers always wore gloves when milking. Almost all cows on large operations (96.7 percent) were on operations in which the milkers always wore latex or nitrile gloves.

C.2.d. Percentage of cows by how often milkers wore latex or nitrile gloves when milking cows, and by herd size and region:

Percent Cows

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Frequency	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Always	50.5	(6.9)	65.8	(6.0)	96.7	(2.0)	93.7	(3.4)	83.1	(2.7)	87.9	(2.2)
Sometimes	14.0	(4.7)	22.9	(5.6)	3.3	(2.0)	6.2	(3.4)	8.3	(2.0)	7.3	(1.9)
Never	35.5	(6.3)	11.2	(3.5)	0.0	(—)	0.1	(0.1)	8.6	(1.7)	4.8	(0.9)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

3. Forestripping

Forestripping is the manual removal of up to 5 squirts of milk at the beginning of milking and is commonly used to evaluate foremilk for signs of mastitis. This practice also removes milk that has a high concentration of somatic cells, which can decrease the somatic cell count in the bulk tank. Additionally, forestripping improves milk let down and may improve parlor efficiency.

Forestripping all cows at each milking was performed by a lower percentage of small and medium operations (65.1 and 65.9 percent, respectively) than large operations (86.2 percent). Overall, 69.1 percent of operations used forestripping on all cows at each milking, and 11.6 percent of operations did not forestrip any cows.

C.3.a. Percentage of operations by use of forestripping, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
All cows at each milking	65.1	(6.1)	65.9	(6.3)	86.2	(3.5)	79.5	(6.2)	67.9	(4.1)	69.1	(3.8)
All cows at least once daily	4.5	(3.2)	0.0	(—)	0.3	(0.3)	0.6	(0.5)	2.6	(1.9)	2.4	(1.7)
All cows at least once weekly	0.9	(0.9)	0.9	(0.9)	1.4	(1.3)	0.0	(—)	1.1	(0.6)	1.0	(0.6)
Some cows (e.g., with mastitis or fresh cows)	17.5	(4.7)	18.7	(4.6)	6.6	(2.6)	12.5	(5.1)	16.3	(3.1)	15.9	(2.9)
Any	88.0	(4.2)	85.5	(5.4)	94.5	(2.2)	92.6	(3.8)	87.9	(3.0)	88.4	(2.8)
None	12.0	(4.2)	14.5	(5.4)	5.5	(2.2)	7.4	(3.8)	12.1	(3.0)	11.6	(2.8)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

Three-fourths of operations that forestripped cows (75.1 percent) did so before or after teat disinfection was applied, but before disinfectant was removed (dried). A lower percentage of large operations (8.0 percent) forestripped cows after disinfection and drying compared with small and medium operations (30.4 and 26.3 percent, respectively).

C.3.b. For the 88.4 percent of operations that forestripped any cows (table C.3.a), percentage of operations by order of forestripping, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Forestripping order	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Before teat disinfection applied	38.4	(6.9)	31.4	(6.0)	28.2	(5.5)	26.0	(8.9)	35.5	(4.6)	34.5	(4.2)
After applying teat disinfection but before drying teats	31.2	(6.0)	42.3	(6.6)	63.8	(5.6)	56.9	(9.1)	38.6	(4.3)	40.6	(4.0)
After disinfection and after drying	30.4	(6.1)	26.3	(5.5)	8.0	(2.9)	17.1	(5.8)	25.9	(4.0)	25.0	(3.6)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

4. Teat preparation procedures

One goal for any dairy operation should be to make sure cow teats are clean and dry before milking. The most commonly recommended teat preparation method is to apply an approved predip (teat disinfectant) and wait at least 30 seconds before removing it with a single-use paper or cloth towel. Using water to clean teats and udders is not recommended. Water can carry bacteria from the udder to the teat ends, where bacteria are most likely to enter the teat canal. Using a single paper or cloth towel to dry teats on multiple cows (multiple use) is not recommended because bacteria can be transferred from one cow to another.

Wash pens are equipped with sprinklers designed to wash the udder and underside of cows before milking. More than one-fourth of large operations (27.4 percent) and almost half of operations in the West region (45.5 percent) used wash pens. Only 4.4 percent of operations used a water hose in the parlor during teat preparation. The percentage of operations that used a dry wipe to remove debris from teats was similar by herd size and by region; 14.0 percent of all operations used a dry wipe. Wet wipes (any type) were used by a higher percentage of small operations than large operations (24.1 and 2.1 percent, respectively); 15.7 percent of all operations used wet wipes.

Predipping teats before milking was performed by 85.7 percent of operations. The predip application used on over half of operations (58.1 percent) was a commercial predip applied with a cup. A commercial predip applied with a sprayer was used by a higher percentage of operations in the West region (35.2 percent) than in the East region (11.2 percent). Applying commercial predips with a cup was performed by a higher percentage of operations in the East region than in the West region (61.5 and 27.7 percent, respectively). Commercial foam predips were applied to teats on 27.0 percent of large operations and 3.0 percent of small operations. Single-use cloth towels or single-use paper towels were used to dry teats after predip application on 31.7 and 44.5 percent of operations, respectively.

C.4.a. Percentage of operations by teat-preparation method used, and by herd size and region:

	Percent Operations											
	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Method	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Wash pen												
Wash animals in holding pen before they enter parlor	0.9	(0.9)	0.0	(—)	27.4	(4.2)	45.5	(7.6)	0.7	(0.5)	5.2	(1.0)
Water hose												
With disinfectant	0.0	(—)	3.2	(2.1)	3.9	(2.3)	6.7	(3.9)	1.1	(0.7)	1.6	(0.7)
Without disinfectant	1.3	(1.0)	4.7	(3.8)	3.7	(2.1)	5.1	(3.5)	2.5	(1.4)	2.8	(1.3)
Any water hose	1.3	(1.0)	7.9	(4.2)	7.6	(3.0)	11.8	(5.1)	3.6	(1.6)	4.4	(1.5)
Single-use dry wipe for cleaning teats of debris, not for drying teats												
Paper towel	6.3	(3.3)	9.2	(3.1)	0.0	(—)	2.4	(2.4)	6.5	(2.2)	6.1	(2.0)
Cloth towel	4.5	(2.4)	5.1	(2.7)	3.9	(1.6)	3.3	(1.9)	4.7	(1.7)	4.6	(1.5)
Multiple use												
Paper towel	0.0	(—)	2.5	(1.9)	0.0	(—)	0.0	(—)	0.8	(0.7)	0.8	(0.6)
Cloth towel	0.0	(—)	4.2	(1.9)	7.6	(3.5)	0.0	(—)	2.9	(0.9)	2.6	(0.8)
Any dry wipe	10.8	(4.0)	21.0	(4.7)	11.5	(3.8)	5.8	(3.0)	14.9	(2.9)	14.0	(2.6)
Wet wipe with commercial disinfectant												
Single-use towel	10.3	(4.3)	4.2	(3.3)	0.3	(0.3)	0.6	(0.5)	7.4	(2.7)	6.7	(2.4)
Multiple-use towel	7.7	(3.7)	1.1	(1.1)	1.7	(1.7)	3.4	(2.9)	4.8	(2.2)	4.7	(2.0)
Wet wipe with homemade disinfectant												
Single-use towel	1.0	(1.0)	2.9	(2.8)	0.0	(—)	0.0	(—)	1.6	(1.1)	1.4	(1.0)
Multiple-use towel	1.8	(1.8)	0.9	(0.9)	0.0	(—)	2.6	(2.6)	1.1	(1.1)	1.2	(1.0)
Multiple-use sponge with disinfectant	1.8	(1.8)	0.0	(—)	0.0	(—)	0.0	(—)	1.0	(1.0)	0.9	(0.9)
Commercial teat wipes												
Single-use	1.4	(1.4)	0.0	(—)	0.0	(—)	0.0	(—)	0.8	(0.8)	0.8	(0.7)
Multiple-use	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Any wet wipe	24.1	(5.8)	9.1	(4.4)	2.1	(1.7)	6.6	(3.9)	16.8	(3.7)	15.7	(3.4)

continued →

C.4.a. (con't.) Percentage of operations by teat-preparation method used, and by herd size and region:

	Percent Operations											
	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Method	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Predip application with commercial disinfectant applied with…												
Predip cup	63.6	(6.2)	62.0	(6.1)	35.1	(5.4)	27.7	(8.1)	61.5	(4.2)	58.1	(3.9)
Sprayer	10.9	(4.2)	12.0	(4.0)	24.6	(5.5)	35.2	(8.5)	11.2	(2.8)	13.6	(2.7)
Foam	3.0	(1.7)	16.3	(4.3)	27.0	(5.2)	14.3	(5.2)	10.9	(2.0)	11.2	(1.9)
Predip application with homemade disinfectant applied with…												
Predip cup	0.8	(0.7)	0.0	(—)	2.7	(1.6)	2.3	(2.2)	0.7	(0.5)	0.9	(0.5)
Sprayer	1.4	(1.4)	3.7	(3.6)	0.0	(—)	0.0	(—)	2.1	(1.5)	1.9	(1.3)
Foam	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Any predip	79.7	(5.1)	94.0	(2.7)	89.3	(3.5)	79.5	(6.5)	86.4	(3.1)	85.7	(2.9)
Dry teats (after wet wipe or predip) single use												
Paper towel	55.8	(6.4)	42.8	(6.4)	13.2	(4.6)	15.2	(7.6)	47.8	(4.3)	44.5	(4.0)
Cloth towel	18.0	(4.6)	36.3	(5.8)	65.3	(6.1)	52.8	(8.7)	29.4	(3.5)	31.7	(3.3)
Dry teats (after wet wipe or predip) multiple use												
Cloth towel	11.2	(4.8)	12.2	(4.0)	14.4	(4.9)	20.3	(8.0)	11.2	(3.1)	12.1	(2.9)
Paper towel	0.0	(—)	0.7	(0.7)	0.9	(0.9)	0.0	(—)	0.4	(0.3)	0.4	(0.3)
Air dry	12.1	(4.2)	4.8	(2.5)	4.3	(2.3)	9.2	(4.6)	8.4	(2.6)	8.5	(2.4)
Any dry teats	97.1	(2.0)	96.8	(1.9)	98.1	(1.4)	97.6	(2.4)	97.1	(1.3)	97.2	(1.2)
Other	8.3	(3.8)	10.7	(4.1)	9.8	(3.2)	9.1	(4.5)	9.3	(2.7)	9.3	(2.4)

The most common teat preparation routines are listed below. These represent routines used by 68.1 percent of operations. Forestripping was performed before drying of teats on 73.6 percent of these operations (50.1/68.1 percent).

C.4.b. Percentage of operations by the most common teat preparation routine used:

Routine	Percent operations	Std. error
Predip, forestrip, dry teats	22.1	(3.0)
Forestrip, predip, dry teats	14.5	(2.8)
Predip, dry teats, forestrip	13.1	(2.7)
Dry wipe, forestrip, predip, dry teats	6.6	(2.2)
Dry wipe, predip, forestrip, dry teats	4.9	(1.8)
Predip, dry teats	2.7	(0.8)
Dry wipe, predip, dry teats, forestrip	2.4	(1.0)
Wash pen, predip, forestrip, dry teats	2.0	(0.7)
Any other combination	31.9	(3.9)
Total	100.0	

Premilking teat disinfectants (or predips) are used to reduce bacterial contamination on teat ends before milking. Using predips can reduce the amount of bacteria that enter the milk line and can also reduce the chance of introducing new infections during milking. The majority of all operations (95.7 percent) used a premilking teat disinfectant; 55.5 percent of operations used iodophors. Responses to the "other" category primarily indicated the use of peroxide-based predips.

C.4.c. Percentage of operations by primary premilking teat disinfectant used, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Disinfectant	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Iodophor (iodine containing)	48.5	(6.7)	61.5	(6.1)	65.8	(5.3)	67.6	(7.7)	54.2	(4.4)	55.5	(4.1)
Chlorhexidine	13.6	(4.6)	13.1	(4.6)	5.1	(1.7)	0.0	(—)	13.3	(3.1)	12.0	(2.8)
Other	34.8	(6.3)	20.4	(4.7)	22.6	(4.3)	18.8	(5.8)	29.3	(4.1)	28.2	(3.7)
Any*	97.0	(2.1)	94.9	(2.5)	93.5	(3.0)	86.3	(5.7)	96.8	(1.5)	95.7	(1.4)
None	3.0	(2.1)	5.1	(2.5)	6.5	(3.0)	13.7	(5.7)	3.2	(1.5)	4.3	(1.4)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

*Estimates differ from table C.4.a due to item nonresponse.

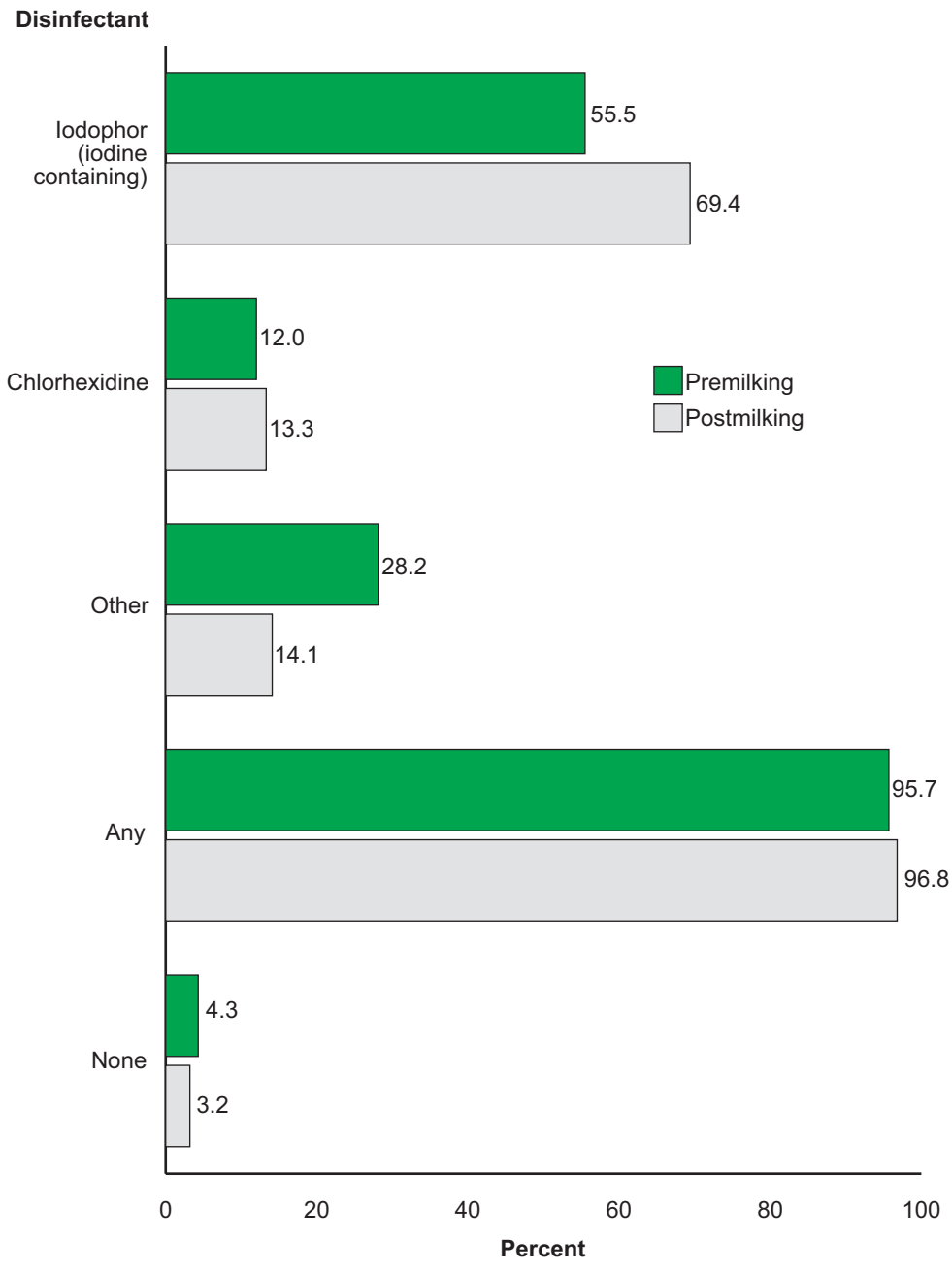
Postmilking teat disinfectants (or postdips) are applied to the part of the teat covered in milk residue during milking. Postdipping is important in preventing transmission of contagious mastitis pathogens, since exposure to contaminated milk is one of the methods of pathogen transmission. Overall, 96.8 percent of operations used a postmilking teat disinfectant. The primary postmilking teat disinfectants used were iodophors (69.4 percent of operations).

C.4.d. Percentage of operations by primary postmilking teat disinfectant used, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Disinfectant	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Iodophor (iodine containing)	65.3	(6.1)	68.0	(6.0)	84.4	(3.9)	78.8	(8.2)	68.3	(4.1)	69.4	(3.8)
Chlorhexidine	16.4	(4.8)	12.1	(4.5)	5.5	(2.7)	13.0	(7.5)	13.3	(3.1)	13.3	(2.9)
Other	13.3	(4.5)	17.8	(4.8)	10.1	(2.9)	8.1	(4.6)	14.8	(3.1)	14.1	(2.8)
Any	95.1	(2.6)	97.8	(1.5)	100.0	(—)	100.0	(—)	96.4	(1.6)	96.8	(1.4)
None	4.9	(2.6)	2.2	(1.5)	0.0	(—)	0.0	(—)	3.6	(1.6)	3.2	(1.4)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

Percentage of operations by primary teat disinfectant used premilking and postmilking



Teats were dipped with a commercial postdip on the majority of operations, regardless of herd size or region. Overall, 80.1 percent of operations dipped teats with a commercial postdip. Almost all large operations and all operations in the West region used a commercial postdip.

C.4.e. Percentage of operations by primary method used to disinfect teats postmilking, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Method	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Dip teats with commercial postdip	82.5	(5.0)	82.2	(4.8)	69.0	(5.3)	62.6	(7.9)	82.0	(3.4)	80.1	(3.2)
Spray teats with commercial postdip	9.3	(4.2)	10.5	(3.9)	16.9	(4.4)	24.1	(6.9)	9.5	(2.8)	11.0	(2.6)
Foam teats with commercial postdip	3.2	(1.8)	5.2	(2.7)	13.7	(4.1)	13.3	(5.4)	4.8	(1.5)	5.6	(1.5)
Dip teats with homemade (not commercial) postdip	0.0	(—)	0.0	(—)	0.5	(0.4)	0.0	(—)	0.1	(0.1)	0.1	(0.1)
Teats covered in commercial powder	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Other	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Any	95.1	(2.6)	97.8	(1.5)	100.0	(—)	100.0	(—)	96.4	(1.6)	96.8	(1.4)
None	4.9	(2.6)	2.2	(1.5)	0.0	(—)	0.0	(—)	3.6	(1.6)	3.2	(1.4)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

The use of wet postdip products in extremely cold weather can occasionally lead to frostbite or development of hyperkeratosis, especially near teat ends where products collect. A higher percentage of medium operations than small operations (42.5 and 17.7 percent, respectively) did not use a wet product in extremely cold temperatures. One-fourth of all operations (27.3 percent) did not use a wet postdip during extremely cold temperatures.

C.4.f. Percentage of operations that did not use a wet postdip during extremely cold temperatures, by herd size and by region:

Percent Operations

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
17.7	(5.3)	42.5	(6.4)	28.7	(5.4)	28.1	(8.7)	27.2	(3.9)	27.3	(3.7)

As the name implies, barrier teat dips are meant to create an impermeable barrier at teat ends to prevent new intramammary (IMM) infections. The majority of operations (58.1 percent) did not use a barrier teat dip. Almost one-third of operations (30.1 percent) used a barrier teat dip on all cows all the time.

C.4.g. Percentage of operations by use of barrier teat dip, and by herd size and region:

Percent Operations

	Herd size (number of cows)											
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**Region** **West**		**Region** **East**		**All operations**	
Use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
All cows on the operation all the time	33.7	(6.1)	27.2	(5.9)	24.0	(5.1)	27.7	(7.9)	30.3	(4.1)	30.1	(3.8)
All cows during winter or adverse weather	2.9	(2.0)	5.5	(2.5)	16.7	(5.7)	19.4	(7.9)	4.6	(1.6)	6.1	(1.7)
Only on selected cows (e.g., mastitis)	5.1	(2.9)	1.0	(1.0)	2.4	(1.8)	2.9	(2.8)	3.5	(1.7)	3.4	(1.6)
Other	2.0	(1.5)	2.8	(2.2)	2.7	(1.3)	1.1	(1.0)	2.5	(1.2)	2.4	(1.1)
Any	43.7	(6.4)	36.5	(6.2)	45.8	(5.8)	51.1	(8.5)	40.9	(4.3)	41.9	(4.0)
None	56.3	(6.4)	63.5	(6.2)	54.2	(5.8)	48.9	(8.5)	59.1	(4.3)	58.1	(4.0)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

D. Milk Cultures

Culturing milk from individual cows with mastitis can help provide a prognosis and guide therapy. Bulk-tank milk cultures are important in identifying high levels of bacteria and contagious mastitis pathogens. Milk cultures were performed by 57.0 percent of operations; 45.4 percent of operations cultured milk from individual cows and 34.2 percent from bulk-tank milk. Bulk-tank milk samples were cultured on a higher percentage of large operations than small operations (65.9 and 20.4 percent, respectively) and on a higher percentage of operations in the West region than in the East region (58.8 and 31.4 percent, respectively).

D.1. Percentage of operations by source of milk used for culture, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Source	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Individual cows	42.6	(6.5)	44.4	(6.5)	56.0	(5.8)	43.6	(8.3)	45.7	(4.4)	45.4	(4.1)
Bulk-tank milk	20.4	(5.3)	40.2	(6.1)	65.9	(5.5)	58.8	(8.6)	31.4	(3.9)	34.2	(3.6)
String samples*	0.0	(—)	2.1	(1.5)	20.4	(4.5)	15.1	(5.6)	2.9	(0.8)	4.2	(0.9)
Any	48.4	(6.5)	58.8	(6.3)	80.1	(4.9)	73.9	(8.1)	55.1	(4.4)	57.0	(4.0)

*Aggregate samples representing a group/pen of cows, such as fresh cows.

Of the 45.4 percent of operations that cultured milk from individual cows, about half cultured all chronic or nonresponsive cases of clinical mastitis or cows with high somatic cell counts. A higher percentage of large operations cultured milk from fresh cows or all clinical mastitis cases compared with small or medium operations. The only regional difference noted was that a higher percentage of operations in the West region (78.3 percent) cultured all clinical mastitis cases compared with operations in the East region (36.4 percent).

D.2. For the 45.4 percent of operations that performed cultures on milk from individual cows (table D.1), percentage of operations by type of cow typically selected for milk cultures, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Cow type	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Fresh cows	4.4	(3.5)	9.4	(4.3)	34.2	(6.8)	36.3	(11.2)	9.7	(2.8)	12.3	(2.9)
All clinical mastitis cases	33.0	(10.1)	33.4	(9.5)	67.6	(6.6)	78.3	(9.6)	36.4	(6.5)	40.6	(6.0)
Chronic clinical mastitis cases	56.2	(10.7)	55.9	(10.0)	54.6	(7.0)	40.8	(11.5)	57.4	(6.8)	55.8	(6.2)
Clinical mastitis cases that did not respond to treatment	46.2	(10.5)	50.5	(9.9)	48.0	(6.9)	39.9	(11.4)	48.7	(6.7)	47.9	(6.1)
High somatic cell count cows	48.5	(10.9)	43.9	(9.8)	39.4	(6.7)	26.8	(10.6)	47.2	(6.9)	45.2	(6.3)
Other	3.2	(3.2)	14.2	(7.0)	8.8	(3.8)	10.7	(7.0)	7.2	(3.0)	7.6	(2.8)

Commercial laboratories and private veterinary clinics were used to perform milk cultures by 47.2 and 39.0 percent of operations, respectively. Less than 10 percent of operations that cultured milk (7.9 percent) did so on-farm. There were no herd size or regional differences.

D.3. For the 57.0 percent of operations that performed any milk cultures (table D.1), percentage of operations by facility used to perform cultures, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Facility	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Commercial lab	49.8	(10.2)	43.4	(8.4)	47.6	(6.1)	54.8	(9.4)	46.1	(6.1)	47.2	(5.4)
Private veterinary lab (veterinary clinic)	39.2	(9.6)	34.8	(8.1)	44.0	(6.3)	55.2	(9.4)	36.6	(5.8)	39.0	(5.2)
State or university diagnostic laboratory	20.7	(8.4)	29.3	(7.5)	35.0	(6.1)	25.9	(10.2)	27.0	(5.2)	26.9	(4.7)
On farm, by farm personnel	3.1	(3.1)	9.5	(4.6)	14.4	(3.3)	1.6	(1.6)	8.8	(2.5)	7.9	(2.2)

Mastitis pathogens are considered either contagious (cow-to-cow transmission during milking) or environmental (transmitted from the environment to cows, typically between milkings). Although many bacteria can be transmitted both ways, most experts consider *Strep. agalactiae, Staph. aureus*, and *Mycoplasma* to be primary contagious pathogens. Cows are continuously exposed to environmental pathogens, so maintaining clean housing and bedding for cows is important in reducing exposure to these pathogens.

Similar percentages of operations across herd sizes and regions identified *Strep.* spp. and *Staph* spp. Of operations that cultured milk, 79.9 percent identified environmental streptococci and 66.6 percent identified *Staphylococcus aureus.* A higher percentage of large operations identified *E. coli/Klebsiella* than small operations (70.9 and 34.8 percent, respectively). *Mycoplasma* was identified via milk culture on 25.2 percent of large operations but on only 6.1 percent of medium operations; *Mycoplasma* was not found on small operations.

By region, a higher percentage of operations in the West region than in the East region (30.2 and 5.1 percent, respectively) identified *Mycoplasma* via milk culture. Overall, 8.7 percent of operations identified *Mycoplasma*.

D.4. For the 57.0 percent of operations that performed any milk cultures (table D.1), percentage of operations by organisms identified, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Organism	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Environmental strep (*Strep.* spp.) non-*agalactiae*	76.1	(9.5)	85.9	(5.2)	77.8	(5.7)	80.7	(7.2)	79.7	(5.1)	79.9	(4.5)
Staphylococcus aureus	66.6	(10.0)	67.2	(8.1)	65.7	(6.0)	67.5	(8.4)	66.4	(5.8)	66.6	(5.1)
E. coli/Klebsiella/ other gram negative	34.8	(10.1)	58.8	(8.3)	70.9	(6.4)	72.8	(10.3)	49.0	(6.1)	52.4	(5.5)
Coagulase neg. staph (*Staph.* spp.) non-*aureus*	33.8	(10.3)	40.8	(8.2)	51.4	(6.2)	55.9	(9.4)	38.3	(5.9)	40.8	(5.3)
Streptococcus. agalactiae	30.8	(10.0)	50.3	(9.0)	31.7	(6.4)	35.6	(10.3)	37.8	(6.0)	37.5	(5.3)
Mycoplasma	0.0	(—)	6.1	(3.5)	25.2	(5.6)	30.2	(8.5)	5.1	(1.8)	8.7	(2.0)

E. Mastitis Incidence and Treatment

1. Cases and outcome

Mastitis is an inflammation of the mammary gland most often caused by bacterial infection. Producers on almost all operations (99.7 percent) reported having at least one case of mastitis during 2013. About one-fourth of all cows (24.8 percent) had clinical mastitis at some point during 2013. On medium operations, producers reported that 16.4 percent of cows had clinical mastitis during 2013, while producers reported that 25.6 and 26.9 percent of cows had clinical mastitis on small and large operations, respectively.

E.1.a. Percentage of operations and percentage of cows with producer-identified cases of clinical mastitis, by herd size and by region:

Percent

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Parameter	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Operations	100.0	(—)	98.8	(1.2)	100.0	(—)	100.0	(—)	99.6	(0.4)	99.7	(0.3)
Cows	25.6	(3.4)	16.4	(1.6)	26.9	(3.2)	29.9	(4.8)	20.9	(1.6)	24.8	(2.4)

Almost three-fourths of cows with mastitis (72.8 percent) recovered and remained in the herd, and about one-fourth were removed or sold (24.0 percent). Less than 5 percent of all cows with mastitis, regardless of herd size or region, died as a result of mastitis. There were no differences by herd size or region in the percentages of cows that recovered, were removed/sold, or died.

E.1.b. For the 24.8 percent of cows with clinical mastitis (table E.1.a), percentage of cows by clinical mastitis outcome, and by herd size and region:

Percent Cows

	Herd size (number of cows)											
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Outcome	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Recovered and remained in the herd	70.2	(4.5)	62.8	(3.9)	74.5	(2.9)	78.3	(3.7)	68.8	(2.0)	72.8	(2.4)
Removed or sold	27.6	(4.2)	32.9	(3.7)	22.3	(2.6)	19.2	(3.4)	27.5	(1.8)	24.0	(2.2)
Died	2.2	(0.6)	4.3	(0.7)	3.1	(0.4)	2.5	(0.5)	3.7	(0.4)	3.2	(0.4)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

2. Diagnosis and treatment

Owners were responsible for diagnosing mastitis on a higher percentage of operations in the East region than in the West region and on a higher percentage of small or medium operations than on large operations. Managers/herdsman were responsible for diagnosing mastitis on a higher percentage of large operations than on small or medium operations, and milkers were responsible for detecting mastitis on a higher percentage of large than small operations. These findings were expected, since the primary person doing the milking is usually responsible for diagnosing mastitis (table C.1.a).

E.2.a. Percentage of operations by personnel responsible for diagnosing mastitis, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Personnel	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Owner	89.4	(4.1)	83.3	(4.3)	57.7	(5.7)	56.7	(8.3)	85.1	(2.9)	82.2	(2.7)
Milkers	60.9	(6.3)	84.6	(4.4)	92.5	(2.8)	82.2	(6.1)	72.6	(4.0)	73.5	(3.6)
Manager/ herdsman	16.5	(4.7)	32.7	(5.9)	86.0	(3.5)	72.7	(7.1)	29.1	(3.5)	33.6	(3.4)
Other	3.4	(2.3)	0.0	(—)	8.2	(3.0)	9.3	(4.3)	2.5	(1.4)	3.2	(1.3)

Mastitis treatment protocols vary according to herd size, region, and type of operation (conventional versus organic). Since mastitis is primarily caused by a bacterial infection of the udder, antimicrobials are commonly used for treatment. Larger operations are better equipped to move cows with mastitis to a separate pen, which reduces the possibility of drug residues in bulk-tank milk. Although organic operations can use antimicrobials, any milk from an animal administered antimicrobials would no longer be considered organic. Additionally, if organic approved health interventions fail, the animal must still be given all appropriate treatments. Some organic treatments also require a milk and/or meat withhold.

The highest percentage of operations (89.4 percent) used IMM antimicrobials to treat mastitis. Overall, 61.3 percent of operations used frequent forestripping of the affected quarter to treat mastitis, and 50.0 percent used early dry-off. The majority of large operations (90.1 percent) moved cows with mastitis to a separate milking pen, but only 2.5 percent of small operations included this practice in their protocols. The percentage of operations that moved cows with mastitis to a separate pen also differed by region, with a higher percentage of operations in the West region than in the East region using this protocol. A higher percentage of operations in the East region than in the West region (24.7 and 5.4 percent, respectively) used organic/homeopathic remedies to treat mastitis.

E.2.b. Percentage of operations by treatment practice used to treat mastitis, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Practice	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Intramammary (IMM) antimicrobials	87.4	(3.4)	88.4	(3.4)	96.9	(1.6)	94.1	(3.4)	88.8	(2.2)	89.4	(2.0)
Frequent forestripping of affected quarter	62.0	(6.4)	55.1	(6.6)	70.2	(4.6)	78.9	(7.5)	59.4	(4.4)	61.3	(4.0)
Early dry-off	45.4	(6.6)	54.7	(6.5)	55.8	(5.8)	42.6	(8.5)	50.9	(4.4)	50.0	(4.1)
Systemic antimicrobials	36.0	(6.0)	62.6	(6.2)	60.8	(5.7)	32.7	(7.5)	50.1	(4.3)	48.4	(4.0)
Organic/ homeopathic remedies	27.8	(5.6)	23.3	(5.1)	6.9	(2.5)	5.4	(3.1)	24.7	(3.7)	22.7	(3.3)
Moved cows to a separate milking pen	2.5	(1.6)	16.3	(4.1)	90.1	(3.7)	78.3	(7.8)	15.7	(2.1)	22.1	(2.3)
Other	11.9	(4.2)	15.1	(4.4)	10.0	(2.7)	20.3	(7.3)	11.7	(2.8)	12.5	(2.6)

3. Antimicrobial use

Antimicrobials were administered to mastitic cows on 96.9 percent of operations. A higher percentage of operations across herd sizes and regions treated mastitic cows with IMM antimicrobials than systemic antimicrobials.

E.3.a. Percentage of operations that treated mastitic cows with antimicrobials, by route of administration and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Route	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Intramammary (IMM)	87.4	(3.4)	88.4	(3.4)	96.9	(1.6)	94.1	(3.4)	88.8	(2.2)	89.4	(2.0)
Systemic	36.0	(6.0)	62.6	(6.2)	60.8	(5.7)	32.7	(7.5)	50.1	(4.3)	48.4	(4.0)
Any	96.5	(2.1)	98.7	(1.3)	94.8	(2.7)	92.9	(4.8)	97.4	(1.2)	96.9	(1.2)

Across herd sizes and regions, the majority of mastitic cows were treated with an antimicrobial, and 87.3 percent of all mastitic cows were treated with an antimicrobial.

E.3.b. Percentage of cows affected with mastitis (table E.1.a), percentage of cows treated for mastitis with an antimicrobial, and percentage of affected cows treated, by herd size and by region:

Percent Cows

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Mastitis	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Cows affected	25.6	(3.4)	16.4	(1.6)	26.9	(3.2)	29.9	(4.8)	20.9	(1.6)	24.8	(2.4)
Cows treated with an antimicrobial	19.5	(3.1)	14.0	(1.6)	23.9	(3.2)	27.9	(4.8)	16.8	(1.3)	21.7	(2.4)
Affected cows treated with an antimicrobial	76.3	(7.2)	85.4	(3.7)	89.0	(5.5)	93.5	(7.0)	80.4	(4.2)	87.3	(4.4)

Of operations that administered antimicrobials to treat mastitic cows, 40.6 percent used culture and sensitivity results to guide mastitis treatment; there were no differences by herd size or by region.

E.3.c. For the 96.9 percent of operations that administered antimicrobials to mastitic cows (table E.3.a), percentage of operations that used culture and sensitivity results to guide mastitis treatment, by herd size and by region:

Percent Operations

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
38.0	(7.2)	43.7	(7.0)	42.2	(5.6)	26.4	(7.6)	42.2	(4.7)	40.6	(4.3)

Nearly three-fourths of operations (73.0 percent) used cephalosporins as their primary antimicrobials for treating mastitis: 34.4 percent used first generation cephalosporins, and 38.6 percent used third generation cephalosporins. A higher percentage of small operations than medium or large operations used first generation cephalosporins, and a lower percentage of small operations than large operations used third generation cephalosporins. Penicillins were used by similar percentages of operations across herd sizes and regions; 12.6 percent of operations used penicillins as their primary antimicrobials when treating mastitis.

E.3.d. Percentage of operations that used the following classes of antimicrobials as a primary treatment for mastitis, by herd size and by region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Primary antimicrobial class	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Aminoglycoside	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Beta-lactam 1st generation cephalosporin	51.5	(7.3)	16.3	(4.7)	18.1	(4.3)	21.2	(6.6)	35.9	(4.9)	34.4	(4.5)
Beta-lactam 3rd generation cephalosporin	26.1	(6.4)	48.5	(6.9)	56.9	(5.5)	51.3	(9.0)	37.3	(4.5)	38.6	(4.1)
Beta-lactam penicillin	8.6	(3.7)	18.3	(6.7)	13.9	(3.9)	11.3	(5.8)	12.7	(3.3)	12.6	(3.0)
Lincosamide	5.8	(3.4)	9.5	(3.4)	6.0	(2.6)	6.0	(4.1)	7.1	(2.2)	7.0	(2.1)
Tetracycline	0.0	(—)	5.3	(2.7)	0.0	(—)	3.0	(2.9)	1.5	(0.9)	1.7	(0.9)
Other/unknown	1.8	(1.8)	0.9	(0.9)	0.0	(—)	0.0	(—)	1.3	(1.0)	1.2	(0.0)
Any	96.5	(2.1)	98.7	(1.3)	94.8	(2.7)	92.9	(4.8)	97.4	(1.2)	96.9	(1.2)
No treatment but disease	3.5	(2.1)	0.0	(—)	5.2	(2.7)	7.1	(4.8)	2.2	(1.2)	2.7	(1.2)
No disease	0.0	(—)	1.3	(1.3)	0.0	(—)	0.0	(—)	0.4	(0.4)	0.4	(0.4)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

Lincosamide and all three beta-lactam antimicrobials were used as secondary antimicrobials for mastitis treatment by similar percentages of operations.

E.3.e. Percentage of operations that used the following antimicrobials as a secondary treatment for mastitis, by herd size and by region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Secondary antimicrobial class	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Aminoglycoside	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Beta-lactam–1st generation cephalosporin	4.9	(3.4)	13.0	(4.7)	3.9	(2.0)	14.3	(9.0)	6.6	(2.4)	7.3	(2.3)
Beta-lactam–3rd generation cephalosporin	11.7	(5.0)	14.6	(4.3)	21.2	(4.8)	20.7	(7.3)	13.6	(3.3)	14.3	(3.0)
Beta-lactam–penicillin	12.5	(5.0)	9.4	(3.5)	15.0	(3.9)	10.6	(5.5)	12.1	(3.1)	12.0	(2.8)
Lincosamide	10.3	(3.9)	24.0	(6.5)	15.0	(3.5)	8.9	(4.2)	16.1	(3.3)	15.5	(3.0)
Tetracycline	4.6	(2.8)	8.0	(5.0)	5.0	(2.6)	6.8	(4.2)	5.6	(2.4)	5.7	(2.2)
Other/unknown	4.3	(3.0)	0.0	(—)	0.0	(—)	0.0	(—)	2.4	(1.7)	2.2	(1.5)
No secondary antimicrobial	51.7	(7.5)	31.0	(6.3)	39.2	(5.6)	38.7	(9.0)	43.4	(4.9)	42.9	(4.6)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

Of the 21.7 percent of cows affected with and treated for mastitis with antimicrobials, 50.4 percent were given third generation cephalosporins, 24.6 percent were given lincosamide, and 15.2 percent were given first generation cephalosporins as their primary treatment for mastitis. Lincosamide was the primary antimicrobial for mastitis treatment on only 7.0 percent of operations; however, these operations represented 24.6 percent of all cows treated.

E.3.f. For the 21.7 percent of cows treated for clinical mastitis (table E.3.b), percentage of cows by primary antimicrobial class used to treat mastitis, and by herd size and region:

Percent Treated Cows

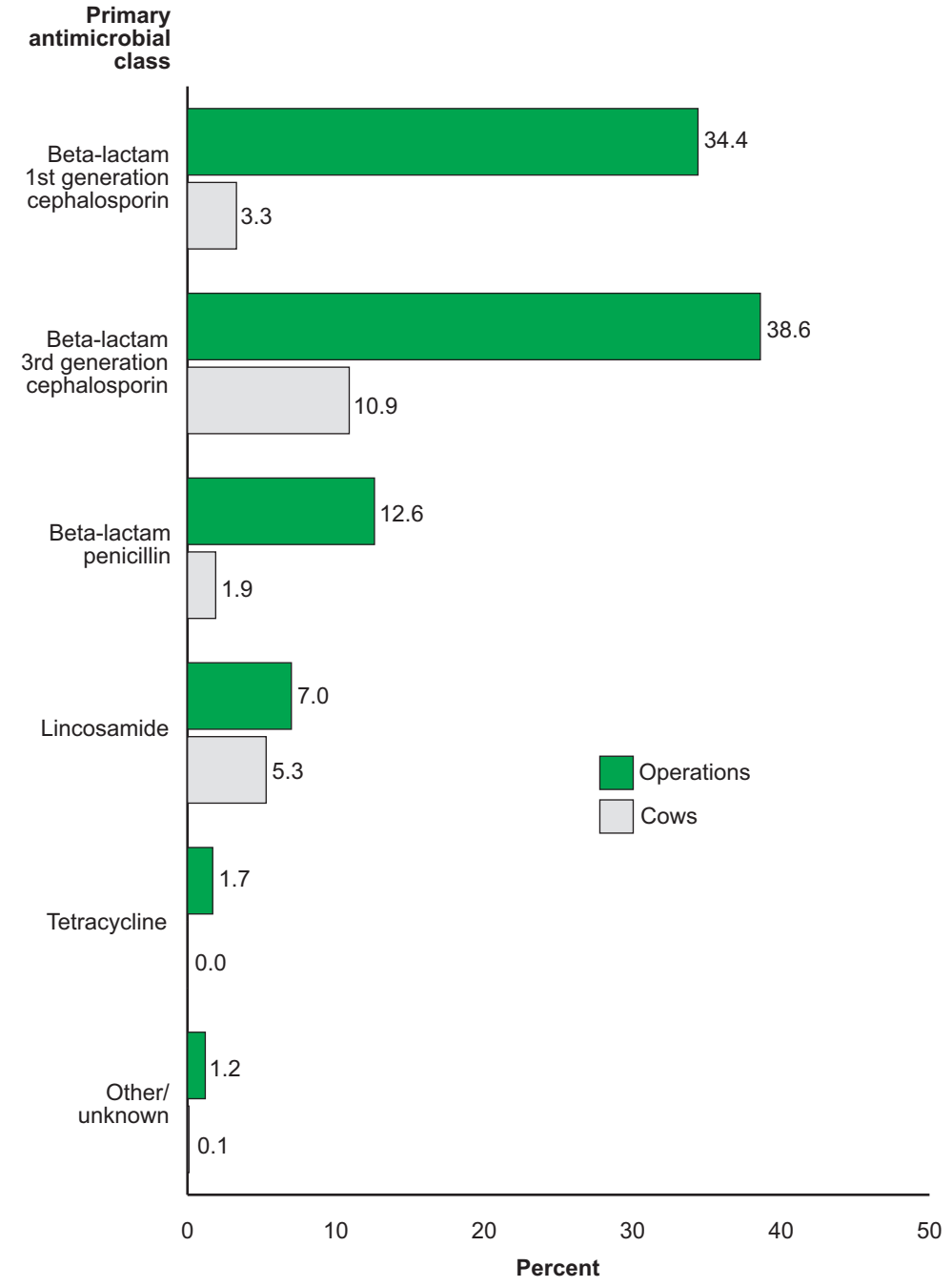
	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Primary antimicrobial class	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Aminoglycoside	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Beta-lactam 1st generation cephalosporin	46.6	(10.7)	19.5	(6.9)	11.1	(5.2)	11.0	(7.1)	20.6	(3.7)	15.2	(4.5)
Beta-lactam 3rd generation cephalosporin	42.4	(11.8)	53.9	(9.2)	50.7	(11.5)	48.0	(15.4)	53.5	(6.1)	50.4	(9.3)
Beta-lactam penicillin	5.1	(2.8)	20.4	(7.9)	7.4	(3.3)	5.4	(3.7)	13.0	(3.9)	8.7	(2.9)
Lincosamide	1.7	(1.2)	2.4	(1.1)	30.4	(13.3)	35.6	(17.5)	10.4	(5.0)	24.6	(11.2)
Tetracycline	0.0	(—)	1.9	(1.3)	0.0	(—)	0.0	(—)	0.5	(0.4)	0.2	(0.2)
Other/unknown	1.6	(1.6)	1.1	(1.1)	0.0	(—)	0.0	(—)	0.6	(0.4)	0.3	(0.2)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

E.3.g. Percentage of cows by primary antimicrobial used to treat mastitis, and by herd size and region:

Percent Cows

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Primary antimicrobial class	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Aminoglycoside	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Beta-lactam 1st generation cephalosporin	9.1	(1.6)	2.7	(1.0)	2.7	(1.2)	3.1	(1.9)	3.5	(0.6)	3.3	(0.9)
Beta-lactam 3rd generation cephalosporin	8.3	(3.4)	7.6	(1.5)	12.1	(2.4)	13.4	(3.6)	9.0	(1.3)	10.9	(1.8)
Beta-lactam penicillin	1.0	(0.5)	2.9	(1.2)	1.8	(0.7)	1.5	(1.0)	2.2	(0.7)	1.9	(0.6)
Lincosamide	0.3	(0.2)	0.3	(0.2)	7.3	(3.9)	10.0	(6.2)	1.7	(0.9)	5.3	(2.9)
Tetracycline	0.0	(—)	0.3	(0.2)	0.0	(—)	0.0	(—)	0.1	(0.1)	0.0	(0.0)
Other/unknown	0.3	(0.3)	0.2	(0.2)	0.0	(—)	0.0	(—)	0.1	(0.1)	0.1	(0.0)
Total	19.5	(3.1)	14.0	(1.6)	23.9	(3.2)	27.9	(4.8)	16.8	(1.3)	21.7	(2.4)

Percentage of operations and percentage of cows by primary antimicrobial class used to treat mastitis



About half of operations that used IMM antimicrobials to treat mastitic cows (54.9 percent) used different antimicrobials for successive treatment courses for individual cows.

E.3.h. For the 89.4 percent of operations that used IMM antimicrobials to treat mastitic cows (table E.3.a), percentage of operations that used different IMM antimicrobials for successive courses of treatment, by herd size and by region:

Percent Operations

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
48.0	(7.2)	64.7	(6.8)	58.4	(6.0)	55.5	(8.8)	54.8	(4.8)	54.9	(4.4)

For operations that used IMM antimicrobials, about 90 percent of operations across herd sizes and regions used historical observation of effectiveness as the criterion when selecting an antimicrobial. Approximately two-thirds of operations used a veterinary recommendation to determine treatment.

E.3.i. For the 89.4 percent of operations that used IMM antimicrobials to treat mastitic cows (table E.3.a), percentage of operations by criterion used to select IMM antimicrobials for mastitis treatment, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Criterion	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Historical effectiveness	93.1	(3.9)	92.2	(3.6)	88.6	(3.4)	86.3	(5.6)	92.7	(2.5)	92.0	(2.3)
Veterinary recommendation	60.6	(7.0)	68.2	(7.1)	77.2	(4.3)	62.9	(8.6)	66.3	(4.7)	65.9	(4.3)
Historical culture and antimicrobial sensitivity results	30.1	(6.4)	33.9	(6.6)	38.8	(5.3)	25.5	(7.2)	33.7	(4.3)	32.8	(4.0)
Individual-cow culture results before therapy	22.5	(6.2)	18.5	(5.1)	27.4	(4.6)	16.8	(6.4)	22.9	(4.0)	22.2	(3.6)
Other	6.3	(3.6)	1.8	(1.8)	9.3	(4.0)	6.1	(3.5)	5.5	(2.3)	5.5	(2.1)

There are seven IMM products approved for use in lactating cows in the United States. The majority of operations that treated cows with IMM products used SPECTRAMAST LC, a third generation cephalosporin (34.4 percent), or Today/Cefa-Lak, a first generation cephalosporin (32.2 percent) as their primary antimicrobial.

E.3.j. For the 89.4 percent of operations that treated mastitic cows with IMM antimicrobials (table E.3.a), percentage of operations by product, primary class of IMM antimicrobial, herd size, and region:

		Percent Operations									
		Herd size (number of cows)						**Region**			
		Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Product (ingredient)	**Primary antimicrobial class**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
SPECTRA-MAST® LC (Ceftiofur)	Beta-lactam 3rd generation cephalosporin	24.1	(6.0)	43.6	(6.8)	47.9	(5.8)	43.8	(9.0)	33.3	(4.2)	34.4	(3.9)
Today®/ Cefa-Lak (Cephapirin sodium)	Beta-lactam 1st generation cephalosporin	47.5	(7.2)	16.2	(4.7)	15.8	(3.8)	18.2	(5.8)	33.8	(4.7)	32.2	(4.3)
Pirsue® Sterile Solution (Pirlimycin)	Lincosamide	5.3	(3.1)	9.4	(3.4)	5.2	(2.3)	5.2	(3.5)	6.7	(2.1)	6.5	(1.9)
Amoxi-mast® (Amoxicillin)	Beta-lactam penicillin	0.7	(0.6)	1.8	(1.8)	2.3	(1.8)	3.5	(3.1)	1.1	(0.7)	1.4	(0.7)
Hetacin®K (Hetacillin potassium)	Beta-lactam penicillin	0.0	(—)	0.0	(—)	4.0	(1.7)	0.0	(—)	0.9	(0.4)	0.8	(0.3)
Hanford's/U.S. Vet MASTI-CLEAR™ (Penicillin G procaine)	Beta-lactam penicillin	1.6	(1.6)	0.0	(—)	0.0	(—)	0.0	(—)	0.9	(0.9)	0.8	(0.8)
Dariclox® (Cloxacillin sodium)	Beta-lactam penicillin	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
No IMM listed as primary antimicrobial		20.6	(5.7)	29.0	(7.1)	24.8	(5.9)	29.3	(9.0)	23.3	(4.1)	23.9	(3.8)
Total		100.0		100.0		100.0		100.0		100.0		100.0	

Producers estimated that, on average, the direct cost to treat a single case of mastitis was $42.05. This amount was similar across herd sizes and regions. IMM antimicrobials accounted for the single highest cost at $13.79 per mastitis case. Labor costs for treating mastitis were higher on large operations ($13.92) than on small and medium operations ($6.73 and $6.12, respectively). The cost for veterinary services was higher on small operations ($9.21) than on large operations ($1.45) and also higher in the East region than in the West region ($7.16 and $1.16, respectively). The difference between what small and large operations spent for the services of a veterinarian is likely due to veterinarians being called to small operations to treat mastitis, while large operations mainly use on-farm labor to treat mastitis. It is important to note that this cost of treatment does not include discarded milk or overall milk loss due to mastitis (indirect costs).

E.3.k. Operation average direct cost of treating a single case of clinical mastitis, by herd size and by region:

Operation Average Direct Cost ($)

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Cost of . . .	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
Intramammary (IMM) antimicrobials	13.66	(1.45)	13.46	(1.29)	14.86	(0.97)	12.23	(1.84)	13.97	(0.96)	13.79	(0.88)
Systemic antimicrobials	8.70	(2.59)	10.48	(2.99)	9.29	(1.66)	4.50	(1.69)	9.85	(1.85)	9.33	(1.68)
Other drugs/ remedies (e.g., Banamine)	5.77	(1.22)	3.18	(0.75)	3.61	(0.61)	3.02	(0.94)	4.82	(0.77)	4.65	(0.70)
Labor	6.73	(1.58)	6.12	(1.63)	13.92	(1.59)	11.69	(2.49)	7.28	(1.10)	7.72	(1.02)
Veterinary services	9.21	(3.36)	4.58	(1.67)	1.45	(0.42)	1.16	(0.50)	7.16	(2.10)	6.57	(1.89)
Total average cost of a single mastitis case	44.07	(6.08)	37.82	(4.48)	43.12	(2.81)	32.60	(4.43)	43.08	(3.94)	42.05	(3.58)

F. Mastitis Vaccination

Of the vaccines available for mastitis, the gram-negative core antigen vaccines (e.g., *E. coli*) are the most effective at preventing or reducing the severity of mastitis, and these vaccines were used by 18.1 percent of all operations. The use of *E. coli* vaccines increased as herd size increased. A very small percentage of operations vaccinated against *Mycoplasma* or *Staphylococcus aureus.* Any vaccine was administered by 18.7 percent of operations.

F.1. Percentage of operations that administered the following vaccines to cows to control or prevent the severity of mastitis, by herd size:

	Percent Operations									
	Herd Size (number of cows)									
	Very small (fewer than 30)		**Small** (30–99)		**Medium** (100–499)		**Large** (500 or more)		**All operations**	
Vaccine	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
E. coli	2.4	(1.7)	12.4	(1.8)	27.1	(2.5)	50.8	(2.4)	18.1	(1.2)
Mycoplasma	0.0	(—)	0.0	(—)	0.0	(—)	0.3	(0.2)	0.0	(0.0)
Staphylococcus aureus	1.5	(1.5)	1.9	(0.8)	0.8	(0.4)	0.3	(0.2)	1.4	(0.5)
Any	3.9	(2.2)	13.0	(1.8)	27.5	(2.6)	50.9	(2.4)	18.7	(1.2)

About twice the percentage of operations in the West region than in the East region vaccinated against *E. coli* or administered any vaccine.

F.2. Percentage of operations that administered the following vaccines to cows, by region:

	Percent Operations			
	Region			
	West		**East**	
Vaccine	**Percent**	**Std. error**	**Percent**	**Std. error**
E. coli	35.7	(3.5)	16.5	(1.3)
Mycoplasma	0.0	(—)	0.0	(0.0)
Staphylococcus aureus	0.3	(0.2)	1.5	(0.5)
Any	35.9	(3.6)	17.3	(1.3)

On average, mastitis vaccinations cost $5.41 per cow. There were no cost differences by herd size or region.

F.3. For the 18.7 percent of operations that administered vaccines to cows (table F.1), operation average cost of vaccination per cow, by herd size and by region:

Operation Average Cost Per Cow ($)

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Avg.	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
6.58	(1.28)	3.92	(0.61)	5.46	(0.52)	4.48	(0.91)	5.61	(0.67)	5.41	(0.58)

G. Dry-off Procedures

1. Management

Producers have options when drying off lactating cows. One option is to dry cows off based on a set dry period (set schedule), which is usually 40 to 60 days before an expected calving date. Alternatively, cows that do not maintain an operation's minimum milk production level before reaching a set schedule are dried off based on low production.

Almost all operations (98.8 percent) dried at least some cows off on a set schedule, while more than four-fifths (81.3 percent) also dried some cows off based on a minimum milk production level. Regarding the methods used to dry-off cows, the majority of operations (73.6 percent) abruptly stopped milking some cows, while almost half of operations (47.5 percent) gradually dried off at least some cows by skipping milkings before complete dry-off. A higher percentage of small operations used the gradual dry-off method (66.4 percent) compared with medium or large operations (29.8 and 19.3 percent, respectively).

G.1.a. Percentage of operations by dry-off protocol, dry-off method, herd size, and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Protocol	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Set schedule	97.8	(1.6)	100.0	(—)	100.0	(—)	100.0	(—)	98.7	(0.9)	98.8	(0.8)
Minimum milk-production level	74.4	(5.5)	85.5	(5.1)	94.4	(2.2)	85.7	(5.6)	80.8	(3.6)	81.3	(3.3)
Dry-off method												
Abrupt—abruptly stop milking	65.1	(6.4)	82.1	(5.3)	85.4	(4.6)	79.4	(6.7)	72.9	(4.3)	73.6	(3.9)
Gradual—skip milkings before complete dry-off	66.4	(5.9)	29.8	(6.0)	19.3	(5.0)	25.9	(7.1)	50.0	(4.4)	47.5	(4.1)
Other	1.8	(1.3)	2.3	(2.2)	0.6	(0.6)	0.0	(—)	1.9	(1.1)	1.7	(1.0)

The majority of cows (89.8 percent) were dried off on a set schedule, while only 10.2 percent of cows were dried off based on the cows' milk production levels. Almost half of cows on small operations were dried off abruptly, and half were dried off gradually. For medium and large operations, more than three-fourths of cows were dried off abruptly.

G.1.b. Percentage of cows by dry-off protocol, dry-off method, herd size, and region:

Percent Cows

	Herd size (number of cows)											
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**Region** **West**		**Region** **East**		**All operations**	
Protocol	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Set schedule	86.7	(2.1)	89.7	(1.4)	90.2	(1.9)	89.2	(2.6)	90.4	(1.5)	89.8	(1.5)
Minimum milk-production level	13.4	(2.2)	10.3	(1.4)	9.8	(1.9)	10.9	(2.6)	9.6	(1.5)	10.2	(1.5)
Total	100.0		100.0		100.0		100.0		100.0		100.0	
Dry-off method												
Abrupt—abruptly stop milking	50.4	(5.8)	77.6	(5.8)	86.4	(4.9)	81.6	(7.7)	82.3	(3.8)	82.0	(4.1)
Gradual—skip milkings before complete dry-off	49.2	(5.9)	18.9	(5.0)	13.4	(4.9)	18.4	(7.7)	16.3	(3.6)	17.3	(4.0)
Other	0.4	(0.3)	3.5	(3.4)	0.2	(0.2)	0.0	(—)	1.3	(1.0)	0.7	(0.5)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

The majority of operations (65.7 percent) reduced the quality/energy content of feed at dry-off, which is consistent with changing from a lactating to dry-cow ration. A higher percentage of small operations (79.2 percent) reduced the quality/energy content of feed at dry-off compared with medium and large operations (48.1 and 55.9 percent, respectively). A relatively small percentage of operations (15.0 percent) performed either a California Mastitis Test or other somatic cell count test to evaluate for subclinical mastitis at dry-off.

G.1.c. Percentage of operations by management practices used at dry-off, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Practice	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Perform California Mastitis Test (CMT) or other individual-cow somatic cell count (SCC)	20.2	(5.5)	9.7	(3.5)	8.9	(2.8)	5.4	(3.7)	16.1	(3.5)	15.0	(3.1)
Reduce the quality/energy content of feed	79.2	(5.0)	48.1	(6.4)	55.9	(5.6)	53.0	(8.5)	67.2	(3.9)	65.7	(3.6)
Restrict access to feed	14.5	(4.9)	11.0	(4.3)	0.3	(0.3)	3.2	(2.6)	11.8	(3.2)	10.9	(2.9)
Restrict access to water	1.9	(1.9)	9.5	(4.6)	0.4	(0.4)	0.0	(—)	4.4	(1.9)	3.9	(1.7)

Of operations that restricted cows' access to feed at dry-off, more than half (53.6 percent) did so for more than 12 hours. Of operations that restricted access to water at dry-off, 86.2 percent restricted cows' access to water for more than 12 hours.

G.1.d. For the 10.9 percent of operations that restricted cows' access to feed at dry-off, and for the 3.9 percent of operations that restricted access to water at dry-off (table G.1.c), percentage of operations by how many hours access to feed or water was restricted.

	Percent Operations			
	Feed		Water	
Hours	Percent	Std. error	Percent	Std. error
Less than 12	46.4	(17.4)	13.8	(10.6)
12 or more	53.6	(17.4)	86.2	(10.6)
Total	100.0		100.0	

2. Antimicrobial use

Blanket therapy (treating all cows with IMM antimicrobial drugs at dry-off) is thought to be more effective than selective treatment in curing existing infections and preventing new infections early in the dry period. While no data have linked the use of dry cow therapy to the development of antimicrobial resistance, increased concern about antimicrobial use and resistance has led to the evaluation of selective dry-cow therapy as an alternative to blanket therapy. Approximately 10 percent of all operations (9.2 percent) did not use dry-cow IMM antimicrobials at dry-off. A higher percentage of large operations (94.2 percent) treated 100 percent of cows with IMM antimicrobials at dry-off than small or medium operations (77.5 and 77.1 percent, respectively).

G.2.a. Percentage of operations by percentage of cows treated with dry-cow IMM antimicrobials at dry-off, and by herd size and region:

Percent Operations

	Herd size (number of cows)					
	Small (30–99)	**Medium** (100–499)	**Large** (500+)	**Region**		
				West	**East**	**All operations**
Percent cows	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**
0	10.2 (3.1)	11.2 (3.6)	2.7 (1.5)	7.2 (3.5)	9.4 (2.1)	9.2 (2.0)
1 to 33	7.5 (3.1)	6.5 (3.1)	0.7 (0.7)	2.6 (2.6)	6.4 (2.1)	6.0 (1.9)
34 to 66	1.4 (1.4)	0.8 (0.8)	0.0 (—)	0.0 (—)	1.1 (0.9)	1.0 (0.8)
67 to 99	3.3 (2.3)	4.4 (3.3)	2.3 (1.8)	4.1 (3.1)	3.4 (1.8)	3.5 (1.6)
100	77.5 (4.9)	77.1 (5.3)	94.2 (2.3)	86.1 (5.1)	79.7 (3.3)	80.3 (3.0)
Total	100.0	100.0	100.0	100.0	100.0	100.0

Almost all cows (93.0 percent) were treated with dry-cow IMM antimicrobials at dry-off. A higher percentage of cows on large operations (96.4 percent) were treated at dry-off compared with cows on small or medium operations (81.9 and 82.6 percent, respectively).

G.2.b. Percentage of cows treated with dry-cow IMM antimicrobials at dry-off, by herd size and by region:

Percent Cows

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
81.9	(4.5)	82.6	(4.6)	96.4	(1.6)	94.3	(2.7)	91.9	(1.8)	93.0	(1.6)

The majority of operations (80.3 percent) used IMM antimicrobials on all cows at dry-off. A lower percentage of small and medium operations (77.5 and 77.1 percent, respectively) used IMM antimicrobials on all cows compared with large operations (94.2 percent). Overall, 90.8 percent of operations used some antimicrobials on at least some cows at dry-off.

G.2.c. Percentage of operations by use of IMM antimicrobials at dry-off, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
All cows	77.5	(4.9)	77.1	(5.3)	94.2	(2.3)	86.1	(5.1)	79.7	(3.3)	80.3	(3.0)
Based on SCC	10.5	(3.6)	9.8	(4.3)	2.4	(1.8)	5.7	(3.8)	9.2	(2.6)	8.8	(2.3)
Based on history of mastitis (clinical/ chronic)	10.0	(3.7)	4.0	(2.0)	0.7	(0.7)	2.7	(2.6)	7.0	(2.3)	6.6	(2.0)
Based on milk production	3.7	(2.1)	0.0	(—)	0.6	(0.6)	1.1	(1.1)	2.1	(1.2)	2.0	(1.1)
During adverse weather only	1.2	(1.2)	2.5	(2.5)	0.0	(—)	0.0	(—)	1.6	(1.1)	1.4	(1.0)
During one or more seasons	4.1	(2.3)	7.7	(4.2)	0.6	(0.6)	1.1	(1.1)	5.0	(2.0)	4.6	(1.8)
Any	89.8	(3.1)	88.8	(3.6)	97.3	(1.5)	92.8	(3.5)	90.6	(2.1)	90.8	(2.0)

Inserting antimicrobials into the teat canal can introduce bacteria into the udder. Teat ends, therefore, should be cleaned and disinfected before administering antimicrobials. Teat ends were cleaned with alcohol pads before administering dry-cow IMM antimicrobials on similar percentages of operations across herd sizes and regions; 90.3 percent of all operations that treated dry cows with IMM antimicrobials cleaned teat ends with alcohol pads.

G.2.d. For the 90.8 percent of operations that treated dry cows with IMM antimicrobials (table G.2.c.), percentage of operations that cleaned teat ends with alcohol pads before administering dry-cow IMM antimicrobials, by herd size and by region:

Percent Operations

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
91.3	(4.2)	87.0	(5.1)	92.8	(2.9)	86.8	(5.7)	90.7	(2.9)	90.3	(2.7)

The majority of operations that dry-treated cows with IMM antimicrobials (58.1 percent) administered Cefa-Dri/Tomorrow. About one-fourth of operations administered SPECTRAMAST DC or Quartermaster (27.9 and 24.5 percent, respectively). A higher percentage of small and medium operations (66.4 and 58.8 percent, respectively) administered Cefa-Dri/Tomorrow compared with large operations (33.5 percent). SPECTRAMAST DC was administered on a lower percentage of small operations than large operations (17.1 and 42.4 percent, respectively).

G.2.e. For the 90.8 percent of operations that treated cows with dry-cow IMM antimicrobials (G.2.c), percentage of operations by product administered at dry-off, antimicrobial class, herd size, and region:

Percent Operations

		Herd size (number of cows)						**Region**					
		Small (30–99)		**Medium** (100–499)		**Large** (500 +)		**West**		**East**		**All operations**	
Product (ingredient)	**Antimicrobial class**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Cefa-Dri®/ Tomorrow (cephapirin benzathine)	Beta-lactam 1st generation cephalosporin	66.4	(6.6)	58.8	(6.9)	33.5	(5.2)	29.0	(7.5)	61.6	(4.5)	58.1	(4.2)
SPECTRAMAST® DC (ceftiofur hydrochloride)	Beta-lactam 3rd generation cephalosporin	17.1	(5.6)	37.9	(7.0)	42.4	(5.6)	34.3	(8.8)	27.1	(4.1)	27.9	(3.8)
Quartermaster® Dry Cow Treatment (penicillin G procaine/ dihydrostreptomycin)	Other	19.8	(5.9)	31.1	(6.6)	26.9	(5.6)	24.0	(8.7)	24.5	(4.1)	24.5	(3.8)
Boviclox; Dry-Clox®; Dry-Clox Intramammary Infusion; Orbenin-DC® (cloxacillin benzathine)	Beta-lactam penicillin	7.4	(3.6)	13.1	(5.1)	14.0	(3.4)	7.8	(4.3)	10.6	(2.8)	10.3	(2.5)
Albadry® Plus Suspension (penicillin G procaine/ novobiocin)	Other	6.8	(3.0)	7.9	(4.2)	13.5	(3.8)	19.0	(6.6)	7.0	(2.3)	8.3	(2.1)
Hanford's/US Vet Go Dry (penicillin G procaine)	Beta-lactam penicillin	5.3	(3.0)	1.3	(1.3)	0.8	(0.7)	1.3	(1.2)	3.5	(1.8)	3.3	(1.6)
Gallimycin®-Dry (erythromycin)	Macrolide	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Biodry® (novobiocin)	Aminoglycoside	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
Other		4.5	(2.7)	0.0	(—)	1.0	(1.0)	0.4	(0.3)	2.8	(1.6)	2.5	(1.4)

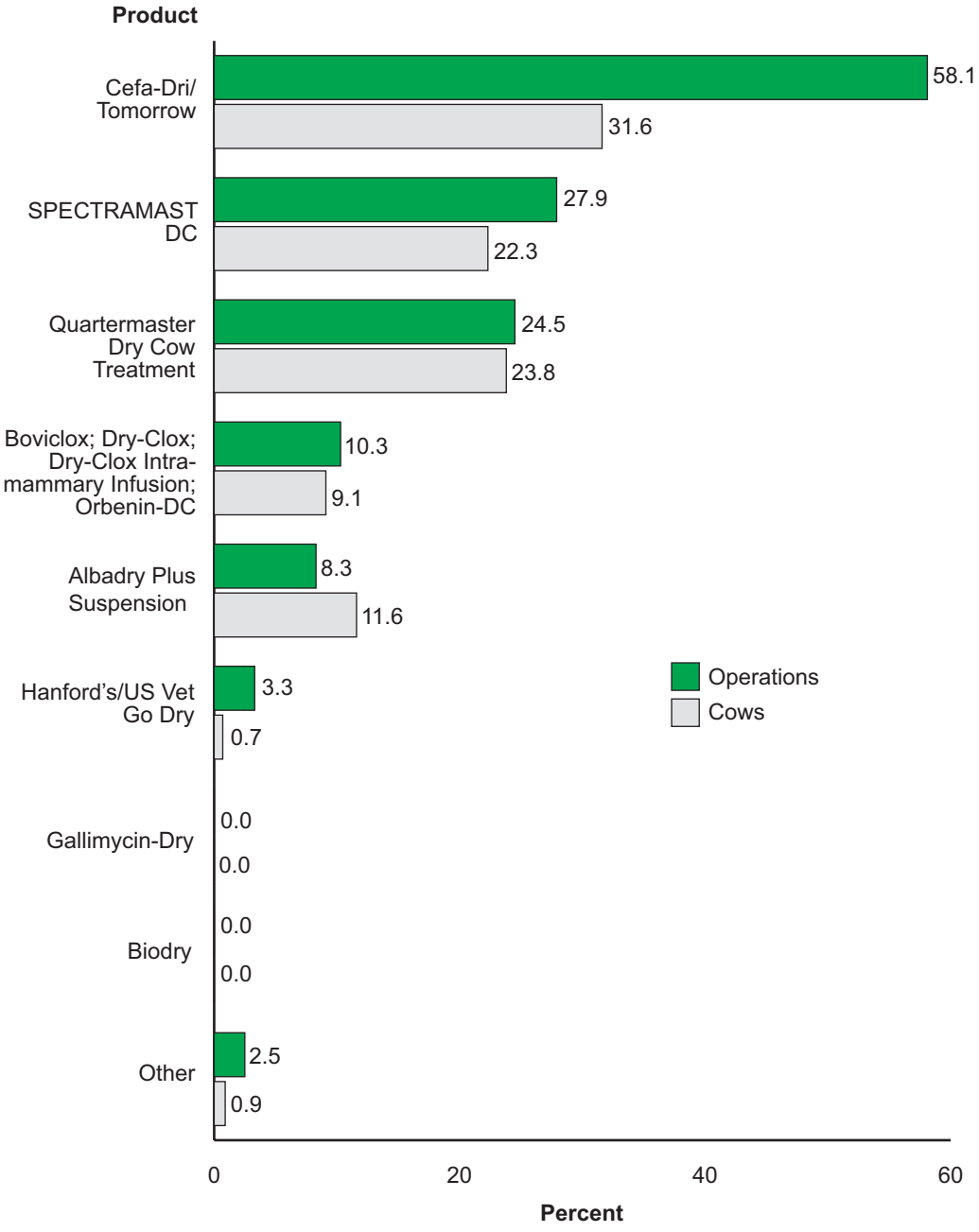
The highest percentages of cows were dry treated with Cefa-Dri/Tomorrow, SPECTRAMAST DC, or Quartermaster (31.6, 22.3, and 23.8 percent, respectively).

G.2.f. For the 93.0 percent of cows treated with dry-cow IMM antimicrobials (G.2.b), percentage of cows by product administered at dry-off, antimicrobial class, herd size, and region:

Percent Cows

		Herd size (number of cows)			**Region**		
		Small (30–99)	**Medium** (100–499)	**Large** (500 or more)	**West**	**East**	**All operations**
Product (ingredient)	**Antimicrobial class**	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**	**Pct.** **Std. error**
Cefa-Dri/ Tomorrow (cephapirin benzathine)	Beta-lactam 1st generation cephalosporin	62.0 (6.1)	39.4 (6.1)	26.3 (6.8)	26.7 (9.9)	36.3 (3.6)	31.6 (5.4)
SPECTRAMAST DC (ceftiofur hydrochloride)	Beta-lactam 3rd generation cephalosporin	6.3 (2.3)	29.5 (6.8)	22.7 (5.0)	19.1 (6.6)	25.5 (3.6)	22.3 (3.9)
Quartermaster Dry Cow Treatment (penicillin G procaine/ dihydrostreptomycin)	Other	12.4 (4.1)	19.4 (5.1)	26.1 (9.4)	29.9 (13.5)	18.0 (2.9)	23.8 (7.3)
Boviclox; Dry-Clox; Dry-Clox Intramammary Infusion; Orbenin-DC (cloxacillin benzathine)	Beta-lactam penicillin	4.5 (2.5)	7.3 (3.3)	10.0 (3.2)	5.8 (3.6)	12.4 (3.0)	9.1 (2.4)
Albadry Plus Suspension (penicillin G procaine/ novobiocin)	Other	5.3 (3.0)	3.9 (2.5)	14.0 (5.2)	18.0 (7.9)	5.3 (1.8)	11.6 (3.9)
Hanford's/US Vet Go Dry (penicillin G procaine)	Beta-lactam penicillin	3.4 (2.1)	0.5 (0.5)	0.4 (0.4)	0.6 (0.6)	0.7 (0.4)	0.7 (0.4)
Gallimycin-Dry (erythromycin)	Macrolide	0.0 (—)	0.0 (—)	0.0 (—)	0.0 (—)	0.0 (—)	0.0 (—)
Biodry (novobiocin)	Aminoglycoside	0.0 (—)	0.0 (—)	0.0 (—)	0.0 (—)	0.0 (—)	0.0 (—)
Other		6.1 (3.6)	0.0 (—)	0.5 (0.5)	0.0 (—)	1.8 (1.0)	0.9 (0.5)
Total		100.0	100.0	100.0	100.0	100.0	100.0

For the 90.8 percent of operations that treated cows with dry-cow IMM antimicrobials, and for the 93.0 percent of cows treated with dry-cow IMM antimicrobials, percentage of operations and percentage of cows by product administered at dry-off



Teat sealants

Teat sealants provide an additional physical barrier that helps prevent bacteria from entering the teat and causing mastitis. There are internal and external teat sealants and both can be used concurrently. Overall, 36.9 percent of operations used an internal teat sealant on at least some cows at dry-off, and 33.9 percent used an internal teat sealant on all cows at dry-off. A lower percentage of small operations (25.8 percent) used internal teat sealants on all cows compared with large operations (57.2 percent).

G.3.a. Percentage of operations by use of an internal teat sealant at dry-off, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
All cows	25.8	(5.9)	34.3	(5.6)	57.2	(4.7)	23.8	(8.1)	35.0	(3.9)	33.9	(3.6)
Based on SCC	0.0	(—)	2.3	(1.6)	0.7	(0.7)	0.0	(—)	0.9	(0.5)	0.8	(0.5)
Based on history of mastitis (clinical/ chronic)	0.0	(—)	2.3	(1.6)	0.0	(—)	0.0	(—)	0.8	(0.5)	0.7	(0.5)
Based on milk production	1.9	(1.9)	1.1	(1.1)	0.0	(—)	0.0	(—)	1.5	(1.2)	1.3	(1.0)
During adverse weather only	1.2	(1.2)	0.0	(—)	0.0	(—)	0.0	(—)	0.7	(0.7)	0.6	(0.6)
During one or more seasons	0.0	(—)	0.8	(0.8)	2.0	(1.6)	2.7	(2.6)	0.3	(0.3)	0.6	(0.4)
Any	28.9	(6.0)	37.3	(5.8)	60.0	(4.7)	26.5	(8.3)	38.1	(4.0)	36.9	(3.7)

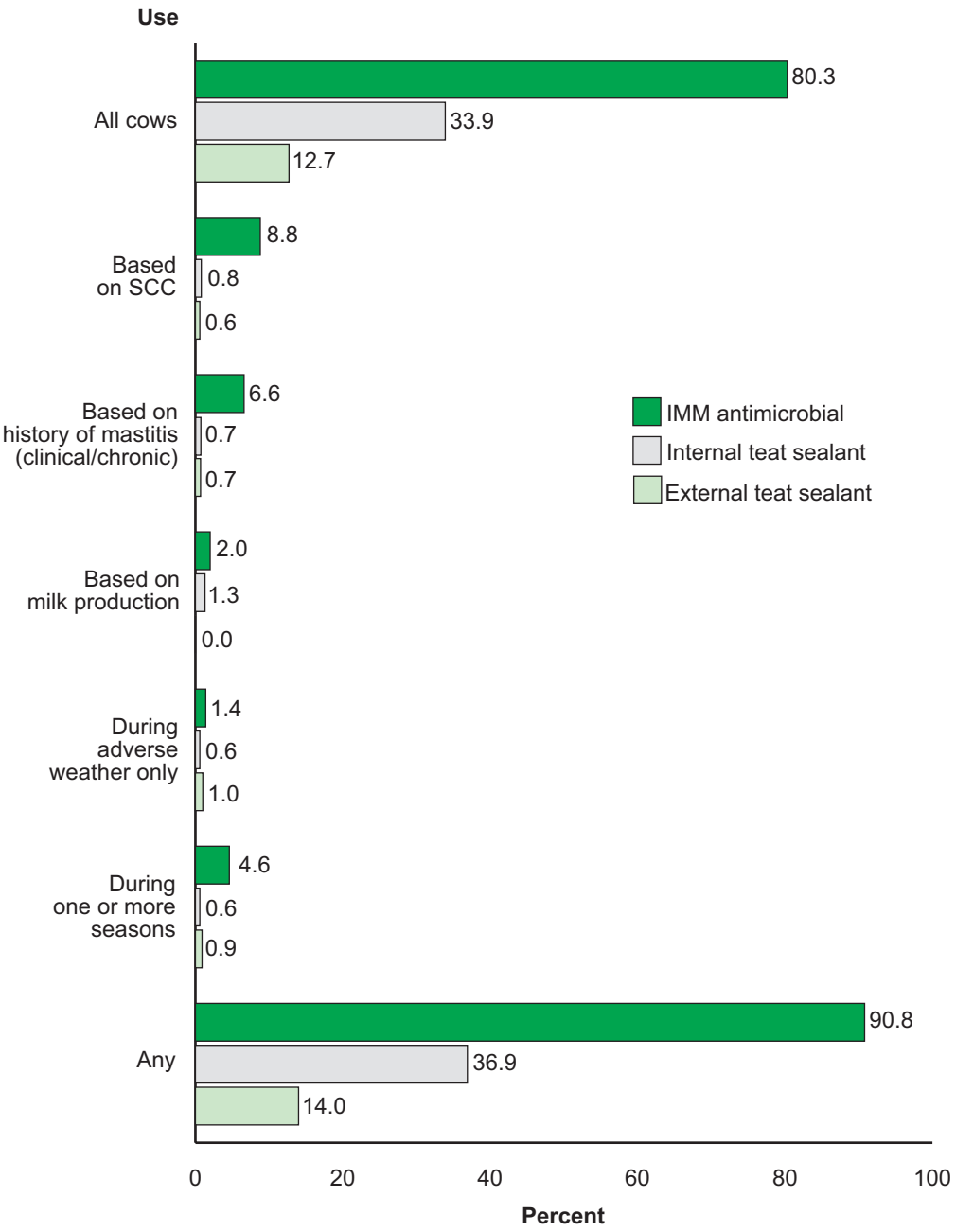
Overall, 14.0 percent of operations used an external teat sealant at dry-off. As was observed with the use of internal teat sealants at dry-off, most operations that used external teat sealants (12.7 percent) used them on all cows.

G.3.b. Percentage of operations by use of an external teat sealant at dry-off, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Use	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
All cows	7.8	(3.2)	15.8	(4.5)	22.4	(4.6)	15.4	(5.6)	12.4	(2.5)	12.7	(2.3)
Based on SCC	1.2	(1.2)	0.0	(—)	0.0	(—)	0.0	(—)	0.7	(0.7)	0.6	(0.6)
Based on history of mastitis (clinical/ chronic)	1.2	(1.2)	0.0	(—)	0.3	(0.3)	0.5	(0.5)	0.7	(0.7)	0.7	(0.6)
Based on milk production	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
During adverse weather only	1.2	(1.2)	0.0	(—)	2.0	(1.6)	3.4	(2.9)	0.7	(0.7)	1.0	(0.7)
During one or more seasons	1.2	(1.2)	0.0	(—)	1.6	(1.5)	2.7	(2.6)	0.7	(0.7)	0.9	(0.7)
Any	9.0	(3.4)	15.8	(4.5)	26.0	(5.0)	21.5	(6.6)	13.2	(2.6)	14.0	(2.4)

Percentage of operations that used IMM antimicrobials, internal teat sealants, or external teat sealants at dry-off, by category of use



On average, it cost $14.45 per cow to administer IMM antimicrobials and apply teat sealants, and costs were similar across herd sizes and regions. For operations that only used IMM antimicrobials at dry off, the cost was $11.62; this cost was also similar across herd sizes and regions.

G.3.c. Operation average cost per cow of IMM antimicrobials and teat sealants normally used at dry-off, by herd size and region:

Operation Average Cost Per Cow ($)

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Used	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**	**Avg.**	**Std. error**
IMM antimicrobials and sealants	13.83	(1.23)	15.39	(0.88)	14.72	(0.96)	11.03	(1.18)	14.83	(0.78)	14.45	(0.72)
IMM antimicrobials only	11.70	(1.30)	11.65	(1.04)	10.97	(1.44)	10.27	(1.24)	11.79	(0.99)	11.62	(0.89)

H. Residue Testing and Prevention

1. Residue testing

Every tanker load of milk in the United States is tested for beta-lactam residues before processing at the milk plant. The presence of beta-lactam residues in milk has declined over the last decade. In 2015, residues were detected in only 0.012 percent of tanker loads tested. Consequences of a positive test include discarding the entire truckload of milk and the possible suspension of the producer's permit to sell milk. Milk from cows treated with antimicrobials should be discarded for a specified withdrawal period, as directed by the manufacturer's product label. Manufacturers are required to go through an exhaustive drug approval process that determines withdrawal periods. If approved, and drugs are used in the manner prescribed by their label, producers can use the withdrawal period stated on the label to ensure that the milk does not contain violative drug residues. However, producers may use on-farm drug residue testing to be confident that the milk is free from violative drug residues.

One concern with regard to on-farm drug testing is that residue testing kits are approved for bulk-milk testing and not for individual cows. Using residue tests on individual cows may result in milk being discarded, even though the residue is below the FDA-established violative level for that antimicrobial.

More than 90 percent of operations administered drugs—not limited to antimicrobials—that required a milk withdrawal period or a milk and meat withdrawal period. A lower percentage of small operations (86.5 percent) administered drugs with a milk withdrawal period compared with large operations (99.0 percent). Similarly, a lower percentage of small operations (87.3 percent) administered drugs with a milk or meat withdrawal period compared with large operations (99.0 percent).

H.1.a. Percentage of operations that administered any drugs that required a milk or milk or meat withdrawal period, by herd size and by region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Withdrawal	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Milk only	86.5	(4.1)	92.1	(2.7)	99.0	(1.0)	93.2	(3.7)	90.0	(2.5)	90.4	(2.3)
Milk or meat	87.3	(4.0)	95.6	(2.0)	99.0	(1.0)	98.2	(1.7)	91.2	(2.5)	91.9	(2.2)

Testing milk on-farm for antimicrobial residues is frequently used to evaluate milk from individually treated cows or to screen the bulk tank before milk is shipped. Overall, 70.8 percent of operations did some on-farm testing of milk for antimicrobial residues. A higher percentage of medium operations (81.3 percent) tested milk for antimicrobial residues compared with large operations (56.3 percent). A higher percentage of operations in the East region (74.7 percent) tested milk compared with operations in the West region (35.5 percent).

H.1.b. Percentage of operations that tested milk on-farm for antimicrobial residues, by herd size and by region:

Percent Operations

Herd size (number of cows)						**Region**					
Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Pct.	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
69.6	(5.9)	81.3	(4.8)	56.3	(5.3)	35.5	(8.5)	74.7	(3.9)	70.8	(3.6)

Of operations that tested milk on-farm for antimicrobial residues, more than half (54.3 percent) used Delvotest.

H.1.c. For the 70.8 percent of operations that tested milk on-farm for antimicrobial residues (table H.1.b), percentage of operations by test most commonly used, and by herd size and region:

Percent Operations

	Herd size (number of cows)								**Region**						**All operations**	
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**			**East**						
Test	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**		**Pct.**	**Std. error**		**Pct.**	**Std. error**		
Delvotest®	60.7	(8.9)	57.3	(7.2)	27.5	(6.7)	2.7	(2.0)		57.5	(5.3)		54.3	(5.2)		
Snap® kit (beta lactam or tetracycline)	28.5	(8.5)	32.4	(6.7)	35.7	(6.9)	58.8	(17.6)		29.3	(5.0)		31.1	(4.8)		
Charm Farm	6.6	(3.8)	7.9	(3.3)	28.1	(6.1)	15.3	(9.0)		10.1	(2.5)		10.4	(2.4)		
Penzyme® Milk Test	2.6	(2.6)	0.0	(—)	8.7	(7.9)	23.2	(18.6)		1.3	(1.3)		2.6	(1.8)		
CITE Probe®	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)		0.0	(—)		0.0	(—)		
Other	1.5	(1.4)	2.4	(1.6)	0.0	(—)	0.0	(—)		1.7	(1.0)		1.6	(0.9)		
Total	100.0		100.0		100.0		100.0			100.0			100.0			

Of operations that tested milk on-farm for antimicrobial residues, the highest percentage (89.7 percent) tested individual cows that had been recently treated with antimicrobials. Slightly over half of operations tested milk from fresh cows or the bulk-tank before processor pickup.

H.1.d. For the 70.8 percent of operations that tested milk on-farm for antimicrobial residues (table H.1.b), percentage of operations by source of milk sample tested, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Source	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Individual cows recently treated with antimicrobials	91.4	(4.6)	89.2	(4.6)	84.9	(7.3)	42.3	(14.9)	92.3	(2.8)	89.7	(3.0)
Fresh cows	58.5	(8.8)	59.0	(7.4)	49.1	(8.0)	16.5	(8.0)	59.8	(5.4)	57.3	(5.2)
Bulk tank—before processor pickup	46.4	(8.8)	51.2	(7.6)	71.2	(5.6)	74.8	(11.5)	50.5	(5.5)	51.8	(5.2)
Other	0.0	(—)	1.7	(1.7)	3.3	(2.4)	0.0	(—)	1.2	(0.8)	1.1	(0.7)

2. Residue prevention

The National Milk Producers Federation's "National Dairy FARM Drug Residue Prevention Manual[1]" recommends that producers keep records on all cattle treated with drugs that require a withdrawal period for milk or meat. The record system should be easily accessible to everyone who works with the cattle. Records should be permanent, as they can serve as protection in case of regulatory follow-up and provide a treatment history that can be useful if continued therapy is needed. Producers should be able to show where and how all drugs purchased were used or discarded. While exceedingly rare, violative residues can occur in healthy animals that have not been treated for clinical disease. An example is treatment with some dewormers, which have a withdrawal period.

Treatment records should contain the following basic information:

- Treatment date
- Animal identification
- Dosage
- Route of administration
- Withdrawal time for milk and meat
- Individual who administered the drug
- Drug used
- Duration of therapy

One of the most important methods of ensuring that milk from treated cows does not enter the bulk tank is to mark treated cows so that milkers can identify those cows and exclude their milk from the bulk tank.

For operations that administered any drugs that required a milk or meat withdrawal period, the majority of medium, large, and all operations (76.7, 71.0, and 59.5 percent, respectively) used leg bands to identify treated cows. Treated cows were not marked on 11.9 percent of operations, but almost one-fourth of operations (23.0 percent, table H.2.c) housed treated lactating cows separately from nontreated cows.

[1] National Dairy Farm Program: Farmers Assuring Responsible Management™ "Milk and Dairy Beef Drug Residue Prevention Manual." Published October 15, 2015: www.nationaldairyfarm.com

H.2.a. For the 91.9 percent of operations that administered any drugs that required a milk or meat withdrawal period (table H.1.a), percentage of operations by method used to identify treated cows, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Method	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Leg band	44.1	(7.1)	76.7	(5.8)	71.0	(5.6)	60.1	(8.8)	59.4	(4.6)	59.5	(4.2)
Chalk or other physical markings (e.g., paint)	40.4	(7.0)	8.6	(3.0)	12.5	(5.0)	27.5	(8.6)	24.7	(4.2)	25.0	(3.9)
Cows are not marked*	13.2	(5.0)	8.0	(4.0)	14.8	(3.7)	8.2	(3.7)	12.3	(3.2)	11.9	(2.9)
Other	2.3	(2.1)	6.7	(4.2)	1.7	(1.7)	4.1	(3.1)	3.5	(1.9)	3.6	(1.7)
Total	100.0		100.0		100.0		100.0		100.0		100.0	

*Some cows are moved to separate pens and may not be marked but are segregated.

To prevent residues in milk or meat, the majority of operations either evaluated treatment records or tested individual milk samples before marketing milk (77.4 and 69.1 percent of operations, respectively). A higher percentage of operations in the West region than in the East region (97.3 and 75.0 percent, respectively) evaluated treatment records, while a higher percentage of operations in the East region than in the West region tested individual milk samples before marketing milk (75.6 and 15.3 percent, respectively). The end of a drug withdrawal period was determined by computer-generated dates on a higher percentage of large operations than medium or small operations and by a higher percentage of operations in the West region than in the East region.

H.2.b. For the 91.9 percent of operations that treated cows with any drugs that required a milk or meat withdrawal period (table H.1.a), percentage of operations by practice used to determine when treated cows could return to the milking string or be sold for beef, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Practice	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Treatment records were evaluated	65.9	(6.6)	82.6	(5.0)	99.1	(0.9)	97.3	(2.6)	75.0	(4.2)	77.4	(3.8)
Individual milk samples tested before marketing milk	72.8	(6.3)	75.8	(5.6)	47.8	(5.4)	15.3	(4.4)	75.6	(4.0)	69.1	(3.8)
Computer-generated dates for end of withdrawal period	1.6	(1.6)	10.7	(3.4)	62.8	(5.3)	63.6	(8.5)	10.2	(1.8)	16.0	(2.1)
Individual urine samples tested before marketing for beef	4.6	(3.3)	15.1	(5.3)	5.6	(1.9)	0.6	(0.5)	9.0	(2.7)	8.1	(2.4)
Individual serum samples were tested before marketing for beef	0.0	(—)	0.0	(—)	0.8	(0.6)	0.0	(—)	0.2	(0.1)	0.1	(0.1)
Other	5.3	(3.9)	3.0	(1.7)	2.1	(1.2)	2.7	(2.6)	4.1	(2.2)	4.0	(2.0)
Any	97.7	(1.7)	96.6	(2.6)	100.0	(—)	100.0	(—)	97.5	(1.3)	97.8	(1.2)

To ensure that drug residues do not end up in the bulk tank, nearly all small and medium operations (90.4 and 88.2 percent, respectively) used a bucket to collect milk from treated cows. About three-fourths of small and medium operations tested individual milk samples for residues before marketing milk. More than two-thirds of large operations housed treated lactating and dry cows in separate pens from other lactating cows, milked treated cows at the end of milking, or milked cows into the pipeline but diverted the milk from the bulk tank.

H.2.c. For the 90.4 percent of operations that administered any drugs that required a milk-only withdrawal period (table H.1.a), percentage of operations by method used to prevent drug residues in milk, and by herd size and region:

Percent Operations

	Herd size (number of cows)						**Region**					
	Small (30–99)		**Medium** (100–499)		**Large** (500+)		**West**		**East**		**All operations**	
Method	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**	**Pct.**	**Std. error**
Milk from treated cows was collected in a bucket	90.4	(4.2)	88.2	(5.2)	25.6	(5.0)	32.9	(8.3)	82.6	(3.2)	77.5	(3.1)
Individual milk samples were tested before marketing milk	73.5	(6.3)	77.6	(5.7)	47.5	(5.4)	16.1	(4.7)	76.1	(4.1)	69.8	(3.8)
Treated dry cows were housed separately from lactating cows	47.2	(7.0)	76.0	(5.7)	95.4	(1.6)	84.9	(7.5)	62.9	(4.6)	65.2	(4.2)
Treated cows were milked at the end of milking/after the nontreated cows	57.7	(6.9)	25.1	(5.9)	72.3	(5.1)	67.5	(8.6)	48.4	(4.7)	50.4	(4.2)
Milk from treated cows was milked into the pipeline but the pipeline was diverted from bulk tank	21.5	(5.8)	15.4	(5.4)	69.8	(5.5)	65.9	(8.7)	24.4	(3.9)	28.8	(3.7)
Treated lactating cows were housed separately from nontreated cows	5.0	(2.7)	11.4	(3.8)	89.3	(3.9)	79.7	(8.1)	16.4	(2.4)	23.0	(2.6)
Milk from untreated individual quarters of treated cows entered the bulk tank	14.0	(5.1)	7.1	(4.3)	1.5	(1.1)	0.0	(—)	10.6	(3.2)	9.5	(2.9)
Treated cows were milked in a separate parlor	3.4	(3.4)	1.5	(1.5)	18.3	(4.0)	15.8	(5.7)	5.4	(1.8)	7.0	(1.8)

Section II: Methodology

A. Needs Assessment

NAHMS develops study objectives by exploring existing literature and contacting industry members about their information needs and priorities during a needs assessment phase. The objective of the needs assessment for the NAHMS Dairy 2014 study was to collect information from U.S. dairy producers and other dairy specialists about what they perceived to be the most important dairy health and productivity issues. A driving force of the needs assessment was the desire of NAHMS to receive as much input as possible from a variety of producers, as well as from industry experts and representatives, State and Federal government personnel, veterinarians, extension specialists, university personnel, and dairy organizations. Input was collected via focus groups and through a needs assessment survey.

The needs assessment survey was designed to ascertain the top three management issues, diseases/disorders, and producer incentives. The survey, created in SurveyMonkey®, was available online from late October through the end of December 2012. The survey was promoted via industry-related electronic newsletters, magazines, and Web sites. Organizations/magazines promoting the study included Vance Publishing's "Dairy Herd Management, Dairy Alert," "Dairy Today," "Hoard's Dairyman," NMC, "Journal of the American Veterinary Medical Association," and the American Association of Bovine Practitioners. Email messages promoting the study—and asking for input and providing a link to the online site—were also sent to cooperative members of the National Milk Producers Federation and to State and Federal personnel; 218 people completed the needs assessment questionnaire.

Respondents to the needs assessment represented the following affiliations:

- Veterinarians/consultants—28 percent of respondents
- Federal or State government personnel—26 percent
- University/extension personnel—16 percent
- Dairy producers—11 percent
- Allied industry personnel—7 percent
- Nutritionists—5 percent
- Other—7 percent

After the needs assessment survey was completed, a focus-group session was held on January 7, 2013, with the goal of setting objectives for the study. The group represented academia, industry, and government. These objectives are on page 100 of this report.

B. Sampling and Estimation

1. State selection

The preliminary selection of States to be included in the study was done in February 2013 using data from the USDA's National Agricultural Statistics Service (NASS) February 1, 2013, "Cattle Report." A goal for NAHMS national studies is to include States that account for at least 70 percent of the animal production class of interest and 70 percent of operations with those animals in the United States. In this case, the production class of interest was milking cows. The initial review identified 17 States representing 81.3 percent of the U.S. milk cow inventory and 80.5 percent of operations with milk cows (dairy herds). The States were California, Colorado, Idaho, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Texas, Vermont, Virginia, Washington, and Wisconsin.

A memo identifying these 17 States was provided in March 2013 to the USDA–APHIS–VS CEAH Director and, in turn, the VS Regional Directors. Each Regional Director sought input from the respective States about their inclusion in or exclusion from the study.

2. Operation selection

The list sampling frame was provided by NASS. Within each State a stratified random sample was selected in which strata were defined by size categories. The size indicator was the number of milk cows for each operation. Producers on the NASS list frame in the 17 States who had reported 1 or more milk cows on January 1, 2013, were eligible to be included in the sample for contact in January 2014. Among producers reporting fewer than 30 cows, 500 operations were selected for Phase Ia. For operations reporting 30 or more cows, 3,000 operations were selected for Phase Ib; overall, 3,500 operations were selected for the study.

Operations with 30 or more cows that participated in Phase Ib were invited to participate in data collection for Phase II. Of the 1,191 operations with 30 or more cows that completed the NASS questionnaire, a total of 527 operations agreed via written consent to be contacted by veterinary medical officers to determine whether to complete Phase II.

3. Population inferences

a. Phases Ia and Ib: general dairy management questionnaire

Inferences cover the population of dairy producers with at least 1 milk cow in the 17 participating States. These States accounted for 81.3 percent of milk cows (7,519,600 head) and 80.5 percent of operations (51,596) with milk cows in the United States (2012 Census of Agriculture). See Appendix III for respective data on individual States. All respondent data were statistically weighted to reflect the population from which the

sample was selected. The inverse of the probability of selection for each operation was the initial selection weight. This selection weight was adjusted for nonresponse within each State and size group to allow for inferences back to the original population from which the sample was selected. Operations with 500 cows or more and organic operations were overrepresented in the sample to ensure valid estimates could be generated for these operations.

b. Phase II: Veterinary Services visit

Inferences cover the population of dairy producers with 30 or more milk cows in the 17 participating States. For operations eligible for Phase II data collection (those that completed Phase 1b and had 30 or more cows), weights were adjusted by State and size categories to account for operations that did not want to continue to Phase II. The 17 participating States represented 81.4 percent of U.S. dairy cows on operations with 30 or more cows and 87.8 percent of U.S. dairy operations with 30 or more cows (see Appendix III).

C. Data Collection

1. Phases Ia and Ib: general dairy management questionnaire

All data were collected from January 1 through 31, 2014. Producers with fewer than 30 cows were mailed an abbreviated questionnaire. Producers that did not respond to the mailed questionnaire were contacted for a telephone interview. Telephone interviews were conducted via computer-assisted software from a single NASS phone center. The questionnaire took approximately 30 minutes to complete. For operations with 30 or more cows, NASS enumerators administered the general dairy management questionnaire via an in-person interview, which took an average of 1.5 hours to complete. All data were entered into a SAS data set.

2. Phase II: Veterinary Services visit

From March 6 through July 28, 2014, Federal and State veterinary medical officers (VMOs) and/or animal health technicians (AHTs) collected data from producers during an in-person interview that lasted approximately 2 hours.

D. Data Analysis

1. Phases Ia and Ib: General dairy management questionnaire

a. Validation

NASS State and regional personnel performed initial data validation and edits at the local level. Individual State data files were combined and sent to NAHMS national staff, which performed final data validation on the entire data set.

b. Estimation

Estimation was done with SUDAAN® software (RTI, version 11.0.1). SUDAAN uses a Taylor series expansion to estimate appropriate variances, which account for the stratified sample design.

2. Phase II: Veterinary Services visit

a. Validation

Data collectors sent completed VS questionnaires to their respective State NAHMS Coordinators, who reviewed the questionnaire responses for accuracy. Individual questionnaires were then submitted to NAHMS national staff, who performed data entry and data validation on the entire data set.

b. Estimation.

Estimation was done with SUDAAN software (RTI, version 11.0.1). SUDAAN uses a Taylor series expansion to estimate appropriate variances, which account for the stratified sample design.

E. Sample Evaluation

The purpose of this section is to provide respondent and nonrespondent information. Historically, the term “response rate” was used as a catch-all parameter, but there are many ways to define and calculate response rates. Therefore, the following table presents an evaluation based on a number of measurement parameters, which are identified with an “x” in categories that contribute to the measurement.

1. Phase Ia: general dairy management questionnaire—fewer than 30 cows

A total of 500 operations were selected for the survey. Of these operations, 14.0 percent completed the questionnaire.

			Measurement parameter	
Response category	**Number operations**	**Percent operations**	**Usable[1]**	**Complete[2]**
Completed survey	70[3]	14.0	x	x
Refused survey or inaccessible	430	86.0		
Total	500	100.0	70	70
Percent of total operations			14.0	14.0
Percent of total operations weighted[4]			13.2	13.2

[1]Useable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions for at least one site.
[3]One operation with more than 300 cows was recategorized as a medium-sized operation for data analysis.
[4]Weighted response—the rate was calculated using the initial selection weights.

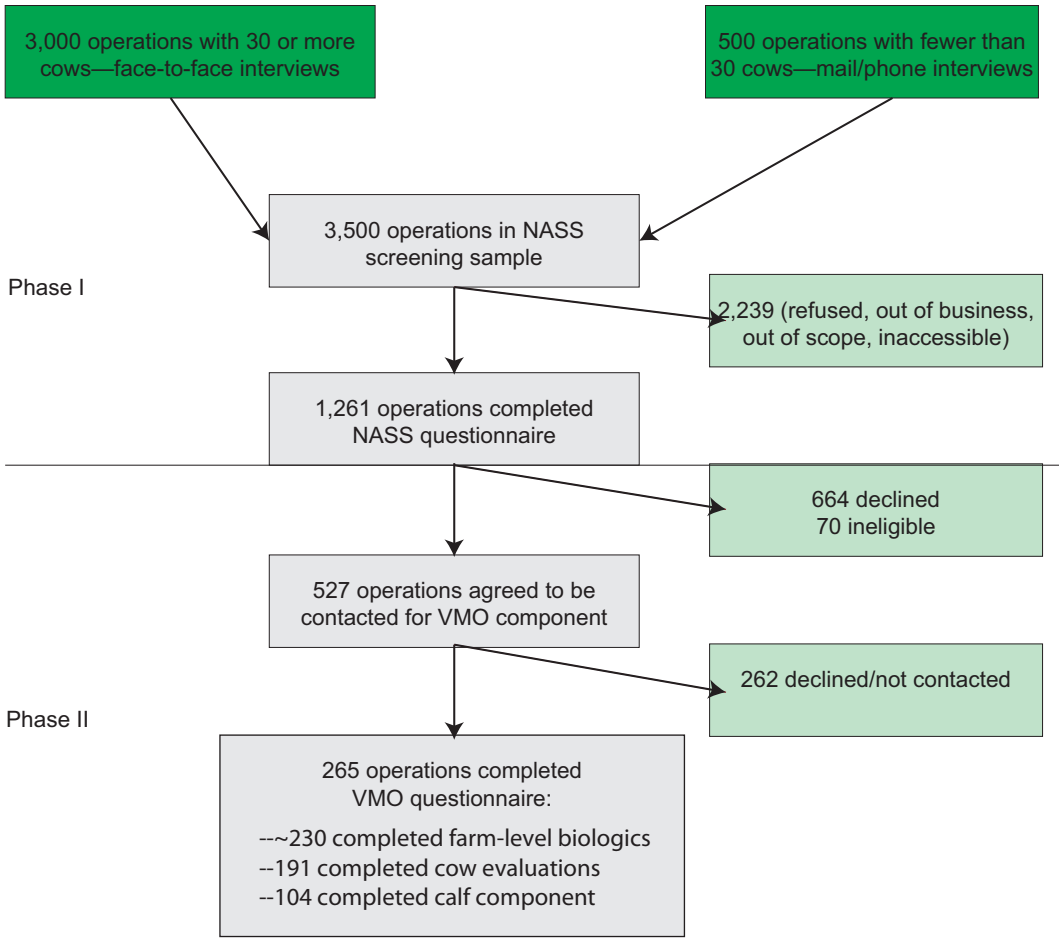
2. Phase Ib: general dairy management questionnaire—30 or more cows

A total of 3,000 operations were selected for the survey. Of these operations, 2,605 (86.8 percent) were contacted. There were 1,580 operations that provided usable inventory information (52.7 percent of the total selected and 60.7 percent of those contacted). In addition, there were 1,191 operations (39.7 percent) that provided complete information for the questionnaire. Of the 1,191 operations that provided complete information and were eligible to participate in the VMO phase of the study, 527 (44.2 percent) consented to be contacted for consideration/discussion about further participation.

				Measurement parameter	
Response category	Number operations	Percent operations	Contacts	Usable[1]	Complete[2]
Survey completed and VMO consent	527	17.6	x	x	x
Survey completed, refused VMO consent	664	22.1	x	x	x
No dairy cows on January 1, 2014	320	10.7	x	x	
Out of business	69	2.3	x	x	
Out of scope (research farm, university, prison, etc.)	8	0.3			
Survey refused	1,025	34.2	x		
Office hold (NASS elected not to contact)	113	3.8			
Inaccessible	274	9.1			
Total	3,000	100.0	2,605	1,580	1,191
Percent of total operations			86.8	52.7	39.7
Percent of total operations weighted[3]			87.3	57.0	38.5

[1]Useable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions for at least one site.
[3]Weighted response—the rate was calculated using the initial selection weights.

Flowchart of respondents



3. Phase II: Veterinary Services visit —30 or more cows

During Phase I, 527 operations agreed to be contacted by a VMO for Phase II. Of these, 265 (50.3 percent) agreed to continue in Phase II of the study and completed the Veterinary Services visit questionnaire; 245 (46.5 percent) refused to participate. Approximately 3 percent of the 527 operations were not contacted, and 0.4 percent were ineligible because they had no dairy cows at the time they were contacted by Veterinary Services during Phase II.

				Measurement parameter	
Response category	**Number operations**	**Percent operations**	**Contacts**	**Usable[1]**	**Complete[2]**
Survey completed	265	50.3	x	x	x
Survey refused	245	46.5	x		
Not contacted	15	2.8			
Ineligible[3]	2	0.4	x	x	x
Total	527	100.0	512	267	265
Percent of total operations			97.1	50.7	50.3
Percent of total operations weighted[4]			98.6	74.3	74.1

[1]Useable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions.
[3]Ineligible—no dairy cows at time of interview, which occurred from May 6 to July 28, 2014.
[4]Weighted response—the rate was calculated using turnover weights.

Appendix I: Sample Profile

A. Responding Operations Phases Ia and Ib: general dairy management questionnaire

1. Number of responding operations, by herd size and by region

	Number of responding operations **Herd Size** (number of cows)				
Region[1]	**Very small** (fewer than 30)	**Small** (30–99)	**Medium** (100–499)	**Large** (500 or more)	**All operations**
West	5	12	47	256	320
East	64	385	296	196	941
Total	69[2]	397	343	452	1,261

[1]Regions:
West: California, Colorado, Idaho, Texas, Washington.
East: Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, Wisconsin.

[2]One operation from Phase Ia with more than 300 cows was recategorized into the medium herd size category.

B. Responding Operations Phase II: Veterinary Services visit

1. Number of responding operations, by herd size and by region

	Number of responding operations **Herd Size** (number of cows)			
Region[1]	**Small** (30–99)	**Medium** (100–499)	**Large** (500 or more)	**All operations**
West	4	4	42	50
East	71	72	72	215
Total	75	76	114	265

[1]Regions:
West: California, Colorado, Idaho, Texas, Washington.
East: Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, Wisconsin.

Appendix II: Antimicrobial Product, by Class

Antimicrobial class	Product	Active ingredient
Aminoglycoside	Adspec®	Spectinomycin
	AmTech Neomycin Oral Solution	Neomycin
	Biosol® Liquid	Neomycin sulfate
	BioDry®	Novobiocin
	Gentamicin	gentamicin
	Neomed 325 Soluble Powder	Neomycin sulfate
	Neomix Ag® 325 Soluble Powder	Neomycin sulfate
	Neomix® 325 Soluble Powder	Neomycin sulfate
	Neomycin 325 Soluble Powder	Neomycin sulfate
	Neomycin Oral Solution	Neomycin sulfate
	Neo-Sol 50	Neomycin sulfate
	Strep Sol 25%	Streptomycin sulfate
	Streptomycin Oral Solution	Streptomycin
Beta-lactam 1st generation Cephalosporin	Cefa-Lak®/ToDAY Intramammary Infusion	Cephapirin (sodium)
	Cefa-Dri®/ToMORROW Infusion	Cephapirin (sodium)
Beta-lactam 3rd generation Cephalosporin	Excede™ Sterile Suspension	Ceftiofur crystalline free acid
	Excenel® RTU	Ceftiofur hydrochloride
	Naxcel®	Ceftiofur sodium
	SPECTRAMAST® DC Intramammary Infusion	Ceftiofur hydrochloride
	SPECTRAMAST® LC Intramammary Infusion	Ceftiofur hydrochloride

continued →

Antimicrobial class	Product	Active ingredient
Beta-lactam penicillin	Agri-Cillin™	Penicillin G Procaine
	Amoxi-Bol®	Amoxicillin
	Amoxi-Inject®	Amoxicillin
	Amoxi-Mast® Intramammary Infusion	Amoxicillin
	Aquacillin™	Penicillin G Procaine
	Aqua-Mast Intramammary Infusion	Penicillin G (procaine)
	Combi-Pen™-48	Penicillin G (benzathine)
	Crysticillin 300 AS Vet.	Penicillin G Procaine
	Dariclox® Intramammary Infusion	Cloxacillin (sodium)
	Dry-Clox®	Cloxacillin (benzathine)
	Duo-Pen®	Penicillin G benzathin; procaine
	Durapen™	Penicillin G benzathin; procaine
	Hanford's/US Vet Masti-Clear Intramammary Infusion	Penicillin G (procaine)
	Hanford's/US Vet/Han-Pen G/Ultrapen	Penicillin G Procaine
	Hanford's/US Vet/Han-Pen-B/Ultrapen B	Penicillin G (benzathine)
	Hetacin®K Intramammary Infusion	Hetacillin (potassium)
	Microcillin	Penicillin G Procaine
	Norocillin	Penicillin G (procaine)
	Orbenin-DC®	Cloxacillin (benzathine)
	Pen-G Max™	Penicillin G (procaine)
	Penicillin G Procaine	Penicillin G Procaine
	PFI-Pen G®	Penicillin G Procaine
	Polyflex®	Ampicillin
	Princillin Bolus	Ampicillin trihydrate
	Pro-Pen-G™ Injection	Penicillin G Procaine
Florfenicol	Nuflor Gold™	Florfenicol
	Nuflor® Injectable Solution	Florfenicol
	Resflor Gold®	Florfenicol and Flunixin meglumine
Fluoroquinolone	Baytril® 100 injection	Enrofloxacin
Lincosamide	Pirsue® Intramammary Infusion	Pirlimycin

continued →

Antimicrobial class	Product	Active ingredient
Macrolide	Draxxin™	Tulathromycin
	Gallimycin®-100 Injection	Erythromycin
	Gallimycin®-36 Intramammary Infusion	Erythromycin
	Micotil® 300 Injection	Tilmicosin phosphate
	Tylan Injection 50/200 Tylosin Injection	Tylosin
	Tylosin Injection	Tylosin
	Zactran	gamithromycin
	Zuprevo 18%	Tilidipirosin
Other	AlbaDry® Plus Suspension	Penicillin G (procaine)/ Novobiocin
	AS700	Chlortetracycline/sulfamethazine
	CORID 20% Soluble Powder	Amprolium
	CORID 9.6% Oral Solution	Amprolium
	Deccox-M	Decoquinate
	Linco-Spectin® Sterile Solution	Lincomycin / Spectinomycin
	Quartermaster® Dry Cow Treatment	Penicillin G (procaine)/ Dihydrostreptomycin
Sulfonamide	20% SQX Solution	Sulfaquinoxaline
	Albon® Bolus	Sulfadimethoxine
	Albon® Concentrated Sol.12.5%	Sulfadimethoxine
	Albon® Injection 40%	Sulfadimethoxine
	Albon® SR Bolus	Sulfadimethoxine
	Di-Methox & 12.5% Oral Solution	Sulfadimethoxine
	Di-Methox Injection 40%	Sulfadimethoxine
	Di-Methox Soluble Powder	Sulfadimethoxine
	Liquid Sul-Q-Nox	Sulfaquinoxaline (sodium)
	SDM Injection 40%	Sulfadimethoxine
	SDM Solution	Sulfadimethoxine
	Sulfadimethoxine 12.5% Oral Solution	Sulfadimethoxine
	Sulfadimethoxine Inj. 40%	Sulfadimethoxine
	Sulfadimethoxine Soluble Powder	Sulfadimethoxine
	Sulfa-Nox Concentrate	Sulfaquinoxaline
	Sulfa-Nox Liquid	Sulfaquinoxaline (sodium)
	Sulfaquinoxaline Sodium Solution 20%	Sulfaquinoxaline (sodium)
	SulfaSure™ SR Cattle/Calf Bolus	Sulfamethazine
	Sulmet® Drinking Water Solution 12.5%	Sulfamethazine (sodium)
	Sulmet® Oblets®	Sulfamethazine
	Sulmet® Soluble Powder	Sulfamethazine (sodium)
	Sustain III® Cattle Bolus	Sulfamethazine
	Vetisulid Injection	Sulfachlorpyridazine (sodium)
	Vetisulid® Powder	Sulfachlorpyridazine (sodium)

continued →

Antimicrobial class	Product	Active ingredient
Tetracycline	Agrimycin™ 100	Oxytetracycline hydrochloride
	Agrimycin™ 200	Oxytetracycline hydrochloride
	AmTech Oxytetracycline HCL Solution Powder - 343	Oxytetracycline
	Aureomycin® Soluble Powder	Chlortetracycline hydrochloride
	Aureomycin® Soluble Powder Concentrate	Chlortetracycline hydrochloride
	Bio-Mycin® 200	Oxytetracycline
	Bio-Mycin® C	Oxytetracycline hydrochloride
	Chlorotetracycline Soluble Powder Concentrate	Chlortetracycline hydrochloride
	CLTC 100 MR	Chlortetracycline calcium
	Duramycin-100	Oxytetracycline hydrochloride
	Duramycin-200	Oxytetracycline hydrochloride
	Liquamycin® LA-200®	Oxytetracycline
	Maxim-200®	Oxytetracycline
	Maxim™-100	Oxytetracycline hydrochloride
	Noromycin® 300-LA	Oxytetracycline
	Oxy 500 and 1000 Calf Bolus	Oxytetracycline hydrochloride
	Oxybiotic™ 200	Oxytetracycline
	Oxycure™ 100	Oxytetracycline hydrochloride
	Oxy-Mycin™ 100	Oxytetracycline hydrochloride
	Oxy-Mycin™ 200	Oxytetracycline hydrochloride
	Oxytet 100	Oxytetracycline hydrochloride
	Oxytetracycline HCL Soluble Powder	Oxytetracycline hydrochloride
	Oxytetracycline HCL Soluble Powder 343	Oxytetracycline hydrochloride
	Oxytetracycline Injection 200	Oxytetracycline
	Oxy-Tet™ 100	Oxytetracycline hydrochloride
	Panmycin® 500 Bolus	Tetracycline hydrochloride
	Pennchlor™ 64 Soluble Powder	Chlortetracycline hydrochloride
	Pennox™ 200 Injectable	Oxytetracycline
	Pennox™ 343 Soluble Powder	Oxytetracycline hydrochloride
	Polyotic® Soluble Powder	Tetracycline hydrochloride
	Promycin™ 100	Oxytetracycline hydrochloride
	Solu/Tet Soluble Powder	Tetracycline hydrochloride
	Terramycin® 343 Soluble Powder	Oxytetracycline hydrochloride
	Terramycin® Scours Tablets	Oxytetracycline hydrochloride
	Terramycin® Soluble Powder	Oxytetracycline hydrochloride
	Terra-Vet 100	Oxytetracycline hydrochloride
	Tet-324	Tetracycline hydrochloride
	Tetra-Bac 324	Tetracycline hydrochloride
	Tetracycline HCL Soluble Powder-324	Tetracycline hydrochloride
	Tetradure™ 300	Oxytetracycline

continued →

Antimicrobial class	Product	Active ingredient
Trimethoprin sulfa	Bactrim® tablets	Trimethoprim/sulfadiazine
	SMZ/TMP Tablets	Trimethoprim/sulfamethoxazole
	TMP-sulfa	Trimethoprim sulfamethoxazole
	Tribrissin® tablets	Trimethoprim/Sulfamethoxazole
	Uniprim Powder	Trimethoprim/sulfadiazine
	Zuprevo 18%	Tilidipirosin

Appendix III: U.S. Milk Cow Population and Operations

Number of milk cows, number of operations, and average herd size for participating States

Region	State	Number of milk cows (thousand head)		Number of operations		Average herd size	
		Milk cows on operations with 1 or more head[1]	Milk cows on operations with 30 or more head[2]	Operations with 1 or more head[1]	Operations with 30 or more head[2]	Operations with 1 or more head	Operations with 30 or more head
West	California	1,815.7	1,814.1	1,931	1,436	940.3	1,263.3
	Colorado	130.7	129.6	517	115	252.8	1,127.0
	Idaho	578.8	577.5	934	540	619.7	1,069.4
	Texas	434.9	431.9	985	512	441.5	843.6
	Washington	267.0	265.4	798	353	334.6	751.8
	Total	3,227.1	3,218.5	5,165	2,956	624.8	1,088.8
East	Indiana	174.1	161.7	2,401	1,010	72.5	160.1
	Iowa	204.8	199.4	1,810	1,230	113.1	162.1
	Kentucky	71.8	67.0	1,564	746	45.9	89.8
	Michigan	376.3	369.2	2,409	1,500	156.2	246.1
	Minnesota	463.3	448.6	4,746	3,720	97.6	120.6
	Missouri	93.0	99.8	2,451	960	37.9	104.0
	New York	610.7	594.6	5,427	3,968	112.5	149.8
	Ohio	267.9	246.4	4,008	2,084	66.8	118.2
	Pennsylvania	532.3	515.3	7,829	6,025	68.0	85.5
	Vermont	134.1	131.7	1,075	769	124.7	171.3
	Virginia	94.1	91.2	1,168	628	80.6	145.2
	Wisconsin	1,270.1	1,241.5	11,543	9,541	110.0	130.1
	Total	4,292.5	4166.4	46,431	32,181	92.4	129.5
Total (17 States)		7,519.6	7,384.9	51,596	35,137	145.7	210.2
Percentage of U.S.		81.3	81.4	80.5	87.8		
Total U.S. (50 States)		9,252.3	9,067.8	64,098	40,017	144.3	226.6

[1]Source: NASS 2012 Census of Agriculture.

[2]Source: NASS 2012 Census of Agriculture special tabulation.

Appendix IV: Study Objectives and Related Outputs

1. Describe trends in dairy cattle health and management practices

    - “Changes in Milking Procedures on U.S. Dairy Operations,” info sheet
    - “Nutrient Management Practices on U.S. Dairy Operations, 2014,” descriptive report
    - “Changes in the “U.S. Dairy Cattle Industry 1991–2014,” descriptive report

2. Describe management practices and production measures related to animal welfare

    - “Dairy Cattle Management Practices in the United States, 2014,” descriptive report
    - “Cattle Welfare on U.S. Dairy Operations, 2014,” interpretive report,
    - “Management of Nonambulatory Dairy Cows on U.S. Dairy Operations,” info sheet

3. Estimate within-herd prevalence of lameness and evaluate housing and management factors associated with lameness

    - “Associations Between Housing and Management Practices on the Prevalence of Lameness, Hock Lesions, and Thin Cows on U.S. Dairy Operations,” info sheet

4. Evaluate heifer calf health from birth to weaning

    - “Dairy Cattle Management Practices in the United States, 2014”
    - “Colostrum Feeding and Management on U.S. Dairy Operations,” 1991–2014, info sheet
    - “Morbidity and Mortality of Preweaned Dairy Heifer Calves,” info sheet
    - “Evaluation of Colostrum Quality and Passive Transfer Status of Dairy Heifer Calves on U.S. Dairy Operations, 2014,” info sheet
    - “Prevalence of *Giardia* and *Cryptosporidium* in Preweaned Dairy Heifer Calves, 2014,” info sheet
    - “Evaluation of Average Daily Gain in Preweaned Dairy Heifer Calves, 2014,” info sheet

5. Describe antimicrobial use and residue-prevention methods used to ensure milk and meat quality

- “Milk Quality, Milking Procedures and Mastitis on U.S. Dairy Operations, 2014,” descriptive report
- “Health and Management Practices on U.S. Dairy Operations, 2014,” descriptive report
- “Antimicrobial Use on U.S. Dairy Operations, 2002–14,” info sheet,

6. Estimate the prevalence and describe antimicrobial resistance patterns of select foodborne pathogens

- *“Listeria* and *Salmonella* in Bulk Tank Milk on U.S. Dairy Operations, 2002–14,” info sheet
- “Prevalence of *Campylobacter* spp. in Bulk-tank Milk and Filters from U.S. Dairies, 2014,” info sheet
- *“Salmonella* Dublin Antibodies in Bulk-tank Milk on U.S. Dairy Operations, 2014,” info sheet
- *“Salmonella* and *Campylobacter* on U.S. Dairy Operations, 2002–14,” info sheet

Additional information sheets

- “Dairy Cattle Identification Practices in the United States, 2014,” info sheet
- “Reproduction Practices on U.S. Dairy Operations, 2014,” info sheet
- “Dairy Cattle Injection Practices in the United States, 2014,” info sheet
- “Off-Site Heifer Raising on U.S. Dairy Operations, 2014,” info sheet
- “Dry-off Procedures on U.S. Dairy Operations, 2014,” info sheet,

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