Preventing Identifying and Treating Mastitis in Small Ruminant Dairy Animals

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Quality Milk Production Services

What Is QMPS?

(Quality Milk Production Services)

- **Established in 1946**
- **Formerly known as the New York State Mastitis Program**
- **Part of the Animal Health Diagnostic Laboratory at Cornell University**


1948


1948


2008

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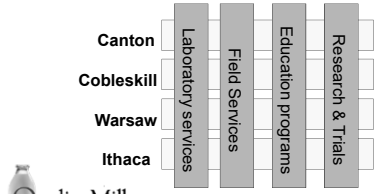
The mission of QMPS is to meet the needs of producers, veterinarians, and the dairy industry through *integrated* on-farm service, diagnostics, education, and research



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Identifying, Treating, and Preventing Mastitis in Small Ruminants

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Objectives

- Mastitis-The Disease and Costs
- Somatic cells and their effects
- Mastitis Pathogens and Management
- Mastitis pathogenesis
- Milk quality measurements
- Mastitis Prevention

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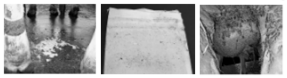
Mastitis Definitions

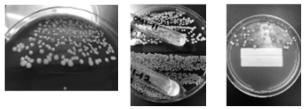
Intramammary Infections

Inflammatory Definition **-mast:** *mastos* 'breast' or 'mammary'
-it is: inflammatory diseases

Clinical Definition

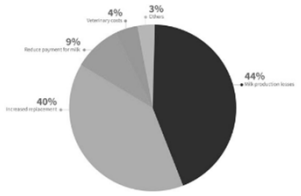


Bacterial Definition



Economic Definition $

Cost of Mastitis



Clinical Mastitis Cost: $293/case

Subclinical Mastitis Cost: $78/goat/year

SOMATIC CELL COUNT	SHEEP	GOATS
1.000.000	-14.1%	-11.4%
2.000.000	-21.1%	-18.8%
3.000.000	-25.20%	-24.2%

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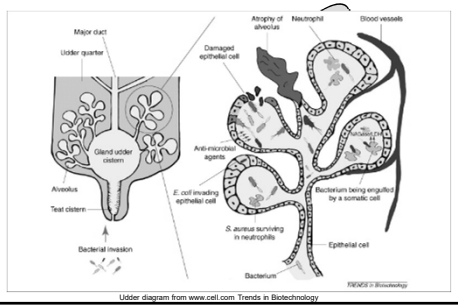
https://aboutsmallruminants.com/analytics-costs-mastitis-sheep-goats/

- **Clinical mastitis:**

- **Subclinical mastitis:**

Mastitis Pathogenesis

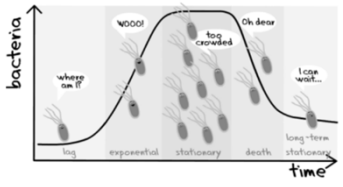
Intramammary Infections



Udder diagram from www.cell.com Trends in Biotechnology

Mastitis...

A pathogen party in the udder



Graph from: Small Things Considered

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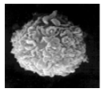
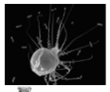
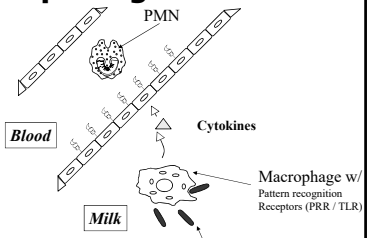
What do you need to thrive?

Macrophages recognize pathogens







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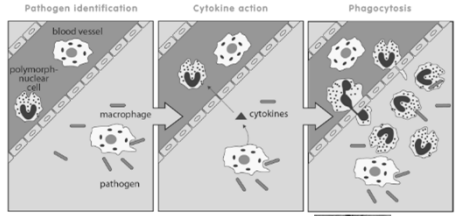
Somatic Cell Migration



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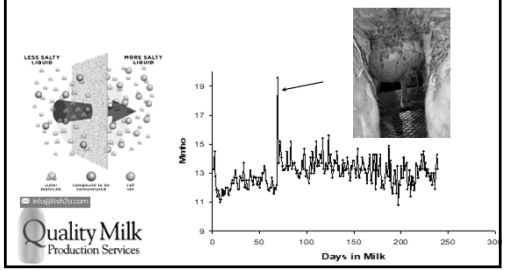
Electrical Conductivity

Further investigation – clinical signs, CMT, SCC are necessary, but signal can be very helpful



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Measurements of Milk Quality

- Bacterial Counts
  - -Standard Plate Count (<100,000 cfu/ml)
  - -Pre-incubation Count
  - -Laboratory Pasteurized Count
  - -Coliform Count
- Somatic Cell Counts (<1,500,000 cells/mL - goats)
- Antibiotic Residues & Inhibitors
- Sediment
- Added Water

Table 1. Suggested Bacterial Test Standards for Quality Premiums

Testing Procedure	Suggested Standard[1]	Regulatory Standard[1]
Standard Plate Count	< 10,000	< 100,000
Laboratory Pasteurization Count	< 200 - 300	none
Preliminary Incubation Count	50,000 – 100,000 and/or Significantly > SPC	none
Coliform Bacteria Count	< 50	California (< 750)

[1] All counts expressed as colony forming units per ml.

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Bacteria Counts

- Standard Plate Count
  - CFU/ml of aerobic bacteria (32^0 F), (<100,000 cfu/ml)
  - Cleaning (equipment, teats), cooling, mastitis
- Pre-incubation Count
  - CFU/ml of bacteria at cool temperatures (55^0 F), (<50-100,000 cfu/ml)
  - Equipment sanitizing, cleaning, hot water, rubber parts,
- Lab Pasteurized Count
  - CFU/ml of thermophilic bacteria (145^0 F), (<100-200 cfu/ml)
  - Sporeforming bacteria, environment, equipment cleaning, animals
- Coliform Count
  - CFU/ml of coliform bacteria, (<10-50 cfu/ml)
  - milking procedures, environmental hygiene, animal hygiene

Effect of Somatic Cells on Milk

Table 1. Effect of somatic cell count on milk quality.

	High level	Low level	SE
Somatic Cell Count (Log_{10})	6.40 A	5.56 B	0.142
Fat (%)	4.39 B	6.93 A	0.143
Protein (%)	5.27	5.32	0.140
Casein (%)	4.25	4.39	0.072
Whey Protein (%)	1.08	1.03	0.086
Non Protein Nitrogen (%)	0.06	0.06	0.003
Urea (mg/dl)	31.69 B	33.07 A	0.303
Lactose (%)	4.38 b	4.71 a	0.085
Total Bacterial Count (Log_{10})	5.89	6.04	0.067
pH	6.79 A	6.68 B	0.006
Titratable acidity (°SH/50 ml)	3.66	4.38	0.263
Calcium (g/l)	1.89	1.93	0.028
Phosphorus (g/l)	1.42	1.35	0.030
Freezing point (°C)	-0.553	-0.557	0.001
r (min) Clotting time	24.11 a	18.96 b	1.181
K_{20} (min)	2.38	1.45	0.095
a30 (mm)	35.50	51.54	5.325
Non reactive milk samples (%)	62.50	12.50	-

On the row different letters are significant at P≤0.05; capital different letters are significant at P≤0.01.

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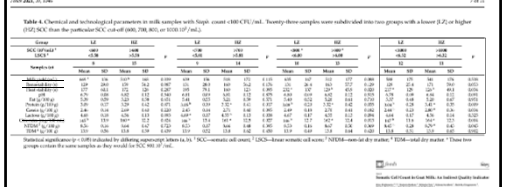
Studies show that sheep milk with a SCC>1,000,000 decreased the cheese yield and increases the development of rancid flavors in the cheese (Jaeggi, 2001).

Effect of Somatic Cells on Milk/Product Quality



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Modes of Milk Secretion

Cow

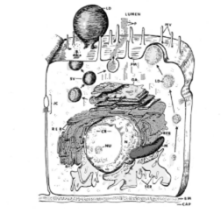
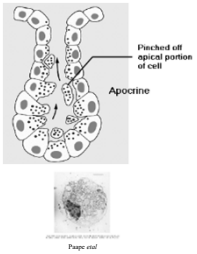


Fig. 1. Three-dimensional diagrammatic representation of a mammary secretory cell showing the structural pathway of the secretory process. Abbreviations: N, nucleus; NU, nucleolus; [illegible]; CR, chromatin; RER, rough-surfaced endoplasmic reticulum; SER, smooth-surfaced endoplasmic reticulum; G, Golgi apparatus; MV, secretory vesicle; LD, lipid droplet (globule); PM, plasma membrane; IC, intercellular canaliculus; M, microvillus; E, enzyme and other secretory products; MC, basolateral membrane; CAP, capillary. See text for description of the structural pathway of milk protein synthesis.

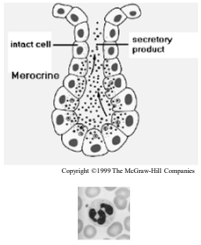
Modes of Milk Secretion

Goat



Paape *etal*
J Anim Sci 1997.75:556-565

Cow



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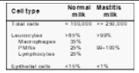
http://cvmstudent.cvm.msu.edu/path/Whatisyourdx.htm

Cellular Immune System
Somatic Cells in Goat Milk

Cell Type	"Normal" Milk	"Mastitis" Milk
Total Cells	270,000-2,000,000 cells/ml	659,000-4,213,000 cells/ml
Macrophage	15-41%	8-18%
PMN	45-74%	71-86%
Lymphocytes	9-20%	5-11
Cytoplasmic Particles	71-306,000 particles/ml	98-231,000 particles/ml

Milk Somatic Cells and Lactation in Small Ruminants



Cows & Sheep

Cellular Immune System
Somatic Cells in Milk

Cell type	Normal milk	Mastitis milk
Total cells	< 100,000	>> 250,000
Leucocytes	>85%	>99%
Macrophages	35%	
PMNs	25%	99-100%
Lymphocytes	25%	
Epithelial cells	<15%	<1%

Cellular Immune System
Somatic Cells in Milk

Sources of Differences in Somatic Cells

- Immune Responses to infections
- Parity
- Stage of lactation
- Season
- Milk yield
- Stress

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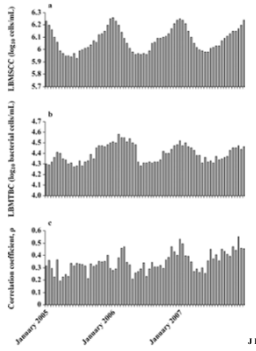
Goat Milk Monthly Patterns



Koop *etal*
J Dairy Sci 92:4355-4364

Breed Differences in Goat Somatic Cell Count

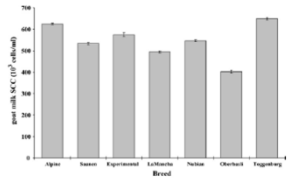


Fig. 7. Effect of breed on composite MSCC for goats. Alpine, $n = 9653$ goats; Saanen, $n = 4619$ goats; Experimental, $n = 1165$ goats; LaMancha, $n = 2851$ goats; Nubian, $n = 4819$ goats; Oberhasli, $n = 859$ goats; Toggenburg, $n = 2641$ goats. Mean (±standard error) MSCC are shown.

Paape *etal*
Small Ruminant Research 68(2007)114-125

Regional Differences in Goat Somatic Cell Count

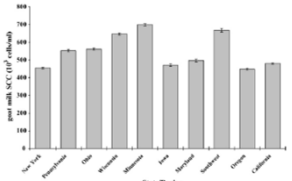


Fig. 9. Herd test-day composite MSCC for goats by state and region of the United States during 2000–2004. NY, $n = 3465$ goats; PA, $n = 1502$ goats; OH, $n = 2929$ goats; WI, $n = 3092$ goats; MN, $n = 3602$ goats; IA, $n = 1414$; MD, $n = 1173$; Southwest, $n = 1148$ goats; OR, $n = 3494$ goats; CA, $n = 4706$ goats. Mean (±standard error) MSCC are shown.

Paape *etal*
Small Ruminant Research 68(2007)114-125

Somatic Cell Count

www.easterndairy.ca

farmfirstdairycooperative.com

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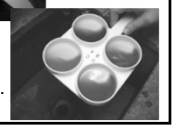
California Mastitis Test (CMT)

SQUIRT…

SLURP…

… equal parts CMT solution and milk



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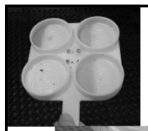
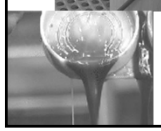
SWIRL…

… for 10 – 20 seconds.





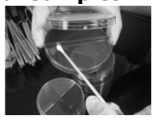
California Mastitis Test

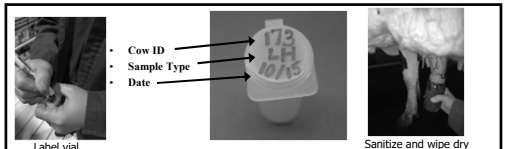
CMT	Cells/ml
N (negative)	0 – 200,000
T (trace)	150,000 – 500,000
1 (Weak Pos)	400,000 – 1,500,000
2 (Positive)	800,000 – 5,000,000
3 (Strong Positive)	> 5,000,000

How Do We Determine What Organisms Are Causing Mastitis?

Bulk Tank Screening

Individual Animal Samples

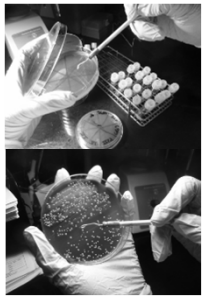




Aseptic Milk Sampling

Milk Cultures

- Within 24 hours of collection or thawing, set-up tests
- After 48 hours, final identification



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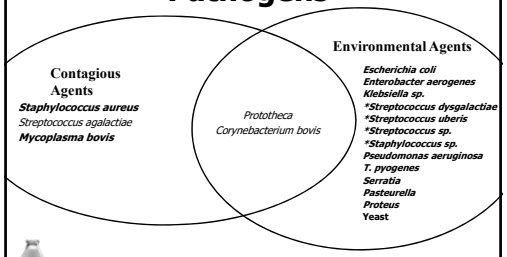
Common Mastitis Pathogens



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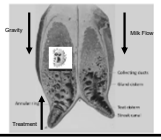
Major Pathogens
* Some response to treatment

Mastitis Management

There are no intramammary antibiotics that are labeled for use in sheep or goats for the treatment of mastitis. Therefore, all treatment of mastitis for sheep and goats is considered extra-label and must done on the advice and under the supervision of a veterinarian. Extra-label is the use of any drug that is used for something that is not specifically listed on the label and is only permitted under the written orders of a veterinarian. Does and ewes with clinical mastitis can be very ill and often require other supportive care. The use of intramammary dry off treatment can help with treatment of mastitis during the dry period but **must be done under the direct recommendation and supervision of a veterinarian** as there are no dry treatment antibiotics labeled for sheep and goats.



Michigan State University
https://www.canr.msu.edu/news/mastitis-in-sheep-and-goats

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Selective Dry Treatment

- 72.5-79% cure rates of infected quarters with dry treatment
- Selective dry treatment recommended
- Blanket treatment recommended if high prevalence of subclinical mastitis (>30-40%)

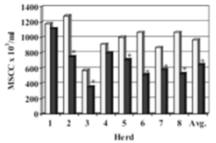

Figure 2. Effect of selective or systematic treatment with antibiotics at dry-off on average bulk tank milk SCC (MSCC) for eight herds for two consecutive lactations. Herds 1 to 6 received selective antibiotic treatment, herds 7 and 8 received systematic treatment. Light bars = lactations during 1997 to 1998, dark bars = lactations during 1998 to 1999. *Significantly lower ($P = 0.0001$) than MSCC in lactation 1997 to 1998. Adapted from Luengo et al. (unpublished data).

Milk Somatic Cells and Lactation in Small Ruminants

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What should you examine to prevent mastitis?

- Average claw vacuum at peak flow
- Pulsation under load
- Unit alignment scoring
- Milking routine timing
- Milk flow rate analysis
- Milking efficiency and throughput timing
- Strip yields
- Teat scoring
- Teat-end cleanliness
- Udder cleanliness

Equipment
People
Animals

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Perform full NMC evaluation if >6 months since previous

Main Equipment Components

- **The Six Basic Parts of a Milking Machine**
  - Vacuum Pump
  - Regulator or Controller
  - Receiver/bucket
  - Pulsator
  - Milking units (claw, cups and inflations)
  - Vacuum Lines

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Basic Machine Function

Differential vacuum between claw and pipeline vacuum moves milk through the long milk tube to milk line.

Air vent lowers vacuum in claw relative to milk tube

Air pushes milk to milk line in a slug up the long milk tube.

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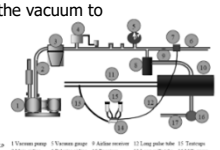
Basic Machine Function

- Milk flows in milk line by gravity, not air movement
- Milk line must have a slope of 1% to get the milk to flow to the receiver jar.
- Once in Receiver Jar, milk is pumped across into the Bulk Tank, going from the vacuum to atmospheric pressure.



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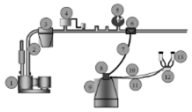
Basic Machine Function

- Vacuum line from the bucket is plugged into a vacuum source.
- Vacuum is placed on the bucket system to operate the pulsator and apply vacuum to the milking unit(s).



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Basic Milking Machine Function

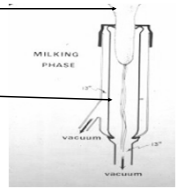
- Vacuum removes milk from teat.

Vacuum differential =

The pressure difference between pressure in the teat and vacuum level in inflation

Positive Pressure inside teat

Vacuum inside inflation



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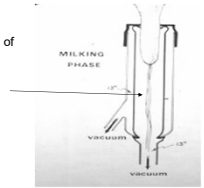
Basic Milking Machine Function

- Vacuum removes milk from teat.

If we kept the vacuum constant in the claw for all of the milking, what would happen?



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Basic Milking Functi

- Vacuum removes milk

Teats would swell due to tournequet effect, and milk flow stops!

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Teat-end Vacuum Levels

Low Line System
34-36 kPa (10.05-10.6" Hg)

Bucket System
44-48 kPa (12.9-14.0" Hg)

High Line System
36-38 kPa (10.6-11.2" Hg)

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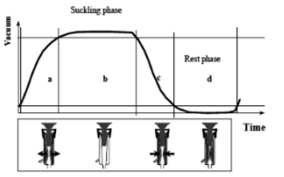
Pulsation



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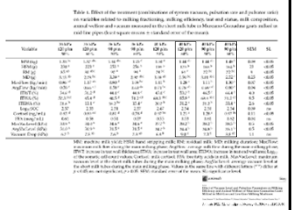
Sheep & Goat Milking System Characteristics

- Pulsation rate: 90-120 pulsations/minute
- Pulsation ratio: 60:40
- 40 kPa/11.8" Hg



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People factors on Milk Quality

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Components of Udder Prep

- **Cleaning teats**
- **Pre-dip**
- **Fore-strip**
- **Drying / Wiping**
- **(Attachment)**
- **Post-dip**

Quality Milk Production Services

Components of Udder Prep

- **Cleaning teats**
  - Removes debris and bacteria
  - Releases oxytocin
  - Disinfect
    - Pre-dip
    - Udder wash
- **Pre-dip**
  - Reduces new infections by 50%
  - Pre-dip better coverage compared to spray

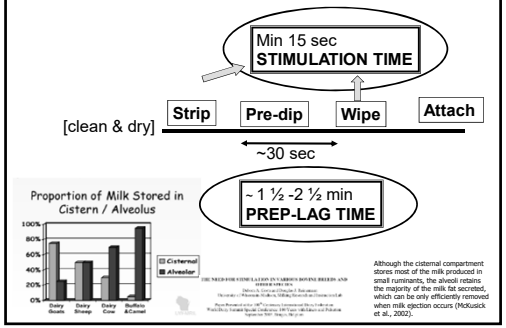
Quality Milk Production Services

Components of Udder Prep

- Forestripping
  - Milk quality
  - Intervene more rapidly
  - Stimulate milk letdown
- Drying
  - Disinfects
  - Reduce the risk of liner slips/squawks
  - Focus on the teat end
- Post-Dip
  - Reduces new cases of mastitis by ~ 50%
  - >75% coverage is necessary

Quality Milk Production Services

Udder Preparation



Animal factors on Milk Quality

Quality Milk Production Services

Teat Condition

- Influenced by a several factors:
  - Effects of milking equipment
    - Mechanical forces exerted by vacuum & liner forces.
  - Milking Management
    - Teat dip, over milking
  - Environment
    - Weather,
  - Goat Factors
  - Risk of New Intramammary Infections

Quality Milk Production Services

Teat End Scoring: Normal

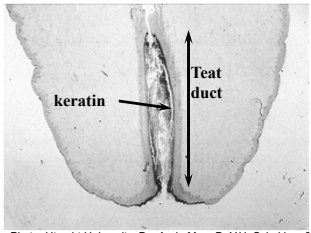
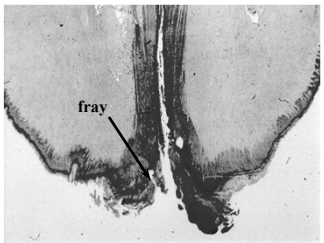


Photo: Utrecht University: Drs A. de Man, Dr Y.H. Schukken & Drs J.P. Koeman

Teat End Scoring:

Very Rough Ring



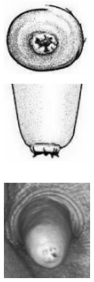


Photo: Utrecht University: Drs A. de Man, Dr Y.H. Schukken & Drs J.P. Koeman

Impact of Teat Lesions

- Increased risk for infection
  - Elevated SCC & Clinical Mastitis
- Decreased milk Yield
- Increased milking time

Quality Milk Production Services

A scoring system for teat-end condition (Mein et al. 2001)

Score	Description	Illustration
N (1)	**Normal** The teat-end is smooth with a small, even orifice. This is a typical status for many teats soon after the start of lactation	
S (2)	**Smooth or Slightly rough ring** A raised ring encircles the orifice. The surface of the ring is smooth or it may feel slightly rough but fronds of old dry keratin are not evident.	
R (3)	**Rough ring** A raised, roughened ring with isolated fronds or mounds of old keratin extending 1 - 3 mm from the orifice.	
VR (4)	**Very Rough ring** A raised ring with rough fronds or mounds of old keratin extending 4 mm or more from the orifice. The rim of the ring is rough and cracked, often giving the teat-end a "flowered" appearance.	

Score Sheet

Quality Milk Production Services

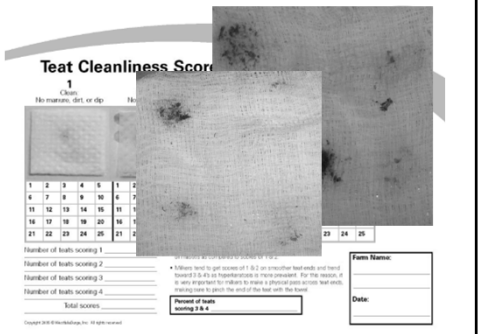
Teat End Lesion Score Sheet

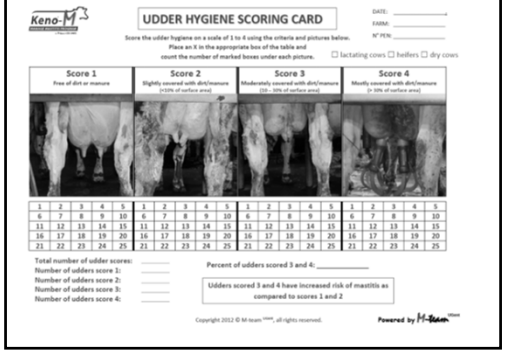
HERD Full House Dairy DATE 12/21/08

SCORER flw

ID	Quarter LH	LF	RF	RH	remarks	ID	Quarter LH	LF	RF	RH	remarks
1420	1	1	1	(1)		1425	1	1	(2)	1	
1230	2	3	(3)	2		1355	2	2	2	2	
1399	(4)	2	2	3		1221	1	2	2	1	
1365	3	3	3	3		1100	2	(4)	4	1	

Quality Milk Production Services





Questions?

Quality Milk
Production Services