



GUIDELINE FOR THE PRODUCTION AND REGULATION OF QUALITY DAIRY GOAT MILK

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Guideline development within Dairy Practices Council (DPC) is unique and requires several levels of peer review. The first step in the process of guideline development starts with a Task Force subcommittee comprised of individuals from industry, regulatory and education interested in and knowledgeable about the subject to be addressed. Drafts, referred to as ‘white copies,’ are circulated until all members are satisfied with the text. The final white copy may then be distributed to the entire Task Force, DPC Executive Vice President and whoever the Task Force Director feels would add to the strength of the review. Following final white copy review and correction, the next step in the process requires a yellow cover draft that is circulated to the member Regulatory Agency representatives that are referred to as “Key Sanitarians.” The Key Sanitarians may suggest changes and insert footnotes if their state standards and regulations differ from the text. After final review and editing the guideline is distributed in the distinctive DPC green cover to people worldwide. These guidelines represent the state of the knowledge at the time they are written.

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INTRODUCTION

It is believed that more of the world's population has access to goat's milk than milk from cattle. In the United States, goat milk is available in limited supply; presently, however, there is a rapidly expanding demand for goat milk and goat milk products, especially cheese.

Regulation of Grade A milk was for years based on a single set of standards as stated in the Pasteurized Milk Ordinance (PMO). Comparison studies conducted on cattle and goat milk indicated significant species differences with resulting compositional differences that preclude the continued reference to a single set of legal quality standards. The compositional differences included: somatic cell content, short-chain fatty acid ratio, casein content, fat content, alkaline phosphatase content, vitamin content and freezing point. When tested by criteria and methodology developed for cattle, normal goat milk could have been judged to be abnormal due to its deviation from the standard levels.

The National Conference on Interstate Milk Shipments (NCIMS) appointed a Goat Milk Committee (now called the Other Species Milk Committee) to determine methods and/or standards that are appropriate for the unique composition of goat milk. By acknowledging the differences, and adjusting the standards and methods, NCIMS has assured that goat milk will be regulated fairly and may be marketed as a high quality Grade A product.

DEFINITIONS

Somatic Cell Count – Leucocyte count used as indicator of udder health in a herd

GUIDELINE CONTENT

This guideline deals with milk quality standards as applied to goat milk and is considered an introductory guideline to goat milk production. The Dairy Practices Council has a Task Force dealing specifically with small ruminant issues and more detailed information is available in other DPC Guidelines. This guideline lists the regulatory standards and laboratory methods that have been identified as appropriate by the National Conference on Interstate Milk Shipments (NCIMS). The guideline also deals with production systems and procedures, as well as management practices, essential for producing high quality goat milk. Refer to additional DPC Guidelines cited throughout the document and in the reference section for more in-depth information

HISTORY OF GOAT MILK IN THE UNITED STATES

The United States dairy goat industry development has been slow when compared to the progress made with dairy cattle. Historically, the small ruminant industry provided meat, milk cheese, and clothing for family use. There were also limited commercial goat cheese markets, centered in the Mediterranean region of Europe and Africa. Sheep and goat populations were maintained, and products were processed on small family-operated dairies. Commercial sale of goat milk as a beverage was almost unknown.



There was little interest in dairy goats in the United States prior to World War II. The era of the Victory Gardens brought companion interest in dairy goats as a component of a wartime survival program. However, general attitudes continued to view goat milk primarily as a substitute for milk from cattle for persons with allergies. Renewed interest in goat milk developed during the 1960-1970 period of "back-to-nature" movements.

Current enthusiasm for goats, goat milk, and goat milk products started in the early 1980's, as goat cheese became a much sought-after gourmet item. Now more United States consumers are recognizing and enjoying the distinctive taste appeal of goat milk products, but as with all of their food products, quality and safety are paramount.

Thus, the 1980's saw a dramatic increase in dairy goat populations and ownership.

Presently the United States dairy goat industry has achieved national and worldwide status. Goat dairies are found in nearly all states today. According to USDA, National Agricultural Statistics Service, 2017 Census of Agriculture there were 35,672 Goat dairy farms in the United States with a total of 537,799 dairy goats. The industry has more than tripled in the past 20 years. The 1997 Census of Agriculture stated there were 11,456 Goat dairy farms in the United States with a total of 146,678 dairy goats. The goat dairy industry while small compared to the rest of the dairy industry in the United States is not as small as most people think. Still there is a serious need for additional goat milk supplies to feed the rapidly expanding demand for goat milk and goat milk products - especially goat milk cheese.

REGULATION - NATIONAL CONFERENCE ON INTERSTATE MILK SHIPMENTS

Legal aspects in goat milk production have undergone an almost complete turnaround over the past thirty-five years. Prior to 1980, there was a lack of communication between goat milk producers and our state and federal regulatory agencies, which has been replaced by cooperation.

As the commercial fluid goat milk industry developed after World War II, certain legal standards for "milk" became very troublesome for goat milk operations. This was especially so as they related to fat and somatic cell content during the fall and early winter months.

Advocates for the goat milk industry began to challenge somatic cell count standards for goat milk some forty-five years ago. The problem of "illegal" somatic cell counts originated in the legal definition that "milk" is milk, regardless of whether it came from cattle or goats. Conflict developed over minimum fat percentage for legal goat milk sales also.

The issue of "illegal" somatic cell counts for goat milk was submitted to the Laboratory Committee of the NCIMS in 1973. NCIMS is the Federal-State cooperative program responsible for maintaining the Grade "A" Pasteurized Milk Ordinance (PMO) which details compositional and sanitary standards for Grade A milk moving in interstate commerce.

In 1975, the Laboratory Committee recommended a study be made of somatic cell counts in goat milk, but no action was taken until 1981 when the Conference appointed a NCIMS Goat Milk Task Force. It became a permanent NCIMS Committee in 1983 and is currently called the Other Species Milk Committee and deals with similar issues facing the sheep dairy industry and other animals that are being considered for commercial milk production.

Two basic areas of concern faced the Other Species Milk Committee. Producers of goat milk suffered repeatedly because their product did not meet milk standards for somatic cell counts and



fat tests developed for cattle, and there were no alternative goat milk standards available. Progress has been significant in resolving both of these issues.

The Committee has been instrumental in providing the data needed to prove to conference delegates (state regulatory agencies) that milk from cattle and goats have many distinct properties and thus should be defined differently in regulatory procedures.

The Committee was able to show that fat tests of goat milk vary widely and routinely fall below milk standards developed for cattle during part of the year. Since little or no goat cream or skim milk is available, goat milk processors are unable to standardize their product as milk processors of milk from cattle do.

Likewise, the Committee determined that production of somatic cells is physiologically different between milk from cattle and milk from goats. Consequently, it became apparent that a different stain was needed that would distinguish between nucleated cells and the non-nucleated cell particles commonly occurring in normal goat milk. Thus, NCIMS delegates mandated that after July 1, 1985, only the Pyronin Y-Methyl Green stain could be used for confirming somatic cell counts in goat milk. Further, when 1991 Conference delegates voted to lower acceptable somatic cell counts for milk from cattle to 750,000 cells/ml, the goat milk standard was allowed to remain at of 1,000,000 cells/ml.

Cooperative efforts with the Committee, the industry, and the regulatory agencies resulted in general acceptance of the concept that milk from goats and cattle are different in many compositional and physical characteristics and thus should have distinct legal definitions. This became a fact at the 1987 Conference with a new legal identity for goat milk. The new definition states: "Goat milk is the normal lacteal secretion, practically free of colostrum, obtained by the complete milking of one or more healthy goats. Goat milk sold in retail packages shall contain not less than 2.5% milkfat and not less than 7.5% milk solids-not-fat. Goat milk shall be produced according to the sanitary standards of this Ordinance. The word 'milk' shall be interpreted to include goat milk."

In 2009 the NCIMS Conference passed a proposal to raise the SCC limit to its current level of 1,500,000 per/ml. Producers still need to be vigilant on mastitis control as the baseline SCC may elevated during rut and mastitis problems will cause a producer to go over the limit. SCC from a healthy herd of early to mid-lactation goats should not exceed 500,000 per ml.

Summary of Issues Resolved:

- Pasteurization standards for time and temperature for goat milk were determined.
- The freezing point for goat milk was determined.
- The milk fat standard for goat milk was defined in the PMO. The PMO definition for goat milk sold in retail packages is not less than 2.5% milkfat and not less than 7.5% solids-not-fat.

Somatic Cell Count (SCC)

- Direct Microscopic Somatic Cell Count (DMSCC)
- Pyronin Y-Methyl Green stain is the official SCC confirmatory test for goat milk.
- The somatic cell count standard for goat milk is 1,500,000 cells/ml.



Natural Inhibitors

Milk from goats contains short chain fatty acids in ratios which are able to act as natural inhibitors. When the *Bacillus sterothermophilus* test was used for the detection of drugs in goat milk, a special confirmatory test had to be used. This was due to the goat milk test indicating a zone of inhibition in excess of the standard for milk from cattle. Now, modern day tests acceptable for drug residue testing in goat milk are validated using milk from goats, so these natural inhibitors are not a problem.

Brucellosis and Tuberculosis

All milk for pasteurization must be from herds under both a Brucellosis and a Tuberculosis (TB) eradication program. The brucellosis ring test is the USDA APHIS approved test for the bovine species and is not suitable for most non-bovine species. For these other species USDA APHIS requires a blood test. The PMO sets out a number of options for brucellosis and tuberculosis testing in Section 8. The following is a summary of the list from the 2017 PMO with tests approved by USDA APHIS for the specific disease (blood testing for brucellosis and the caudal fold tuberculin test for tuberculosis): **See the PMO for the details of each option.**

- Has passed an annual whole herd brucellosis and/or tuberculosis testing as recommended by the State Veterinarian or USDA Area Veterinarian in Charge (AVIC);
- Has passed an initial whole herd brucellosis and/or tuberculosis testing, followed only by testing replacement animals or any animals entering the milking group or sold as dairy animals using tests approved by USDA APHIS;
- Has passed an annual random individual animal brucellosis and/or tuberculosis testing program, using tests approved by USDA APHIS for the specific disease (blood testing for brucellosis and the caudal fold tuberculin test for tuberculosis), sufficient to provide a confidence level of 99% with a P value of 0.05. Any herd with one (1) or more confirmed positive animals shall go to 100% testing until the whole herd tests show no positive animals are found;
- Determined to be free of brucellosis and/or tuberculosis as provided by the development and implementation of a State administered brucellosis-free and/or tuberculosis-free herd certification program involving a documented surveillance program.

QUALITY STANDARDS

Bacteria

To comply with the NCIMS requirements set forth in the PMO, milk must be checked regularly for bacteria. Generally, this is done at least once per month from random samples using the Standard Plate Count (SPC).

The SPC of freshly produced milk is often below 5,000/ml, but most industry standards are at 50,000/ml or below. The regulatory maximum is 100,000/ml. Regulatory action is taken whenever 3 of the last 5 samples are above 100,000/ml.

Maintaining bacteriological quality of goat milk should not be a problem for producers. The same types of environmental microorganisms exist for both goats and cattle. If the SPC is high there is an identifiable reason for the elevation, and it should be investigated.



See (DPC 024, Troubleshooting High Bacteria Counts of Raw Milk) for more information on troubleshooting bacteria counts.

Preliminary Incubation Count (PI)

The PI count is the best measure of raw milk keeping qualities and the sanitation practices used on the farm. Correlating this with the SPC will give a better picture of what is happening on the farm and can relate to the future shelf life of the milk. The milk is incubated at 55°F (12.8°C) for 18 hours for this test. The counts should not exceed 100,000/ml but preferably should be in the 25,000- 50,000/ml range.

Somatic Cell Count (SCC)

Accurate standardization of somatic cell count regulations in goat milk encompasses two separate issues. The first is the use of appropriate methods. Goats produce milk differently than cattle. The goat milk secretion system is apocrine; the system in cattle is merocrine. Apocrine secretion results in the presence of cytoplasmic particles in the milk, the somatic cell count includes nucleated cells only. In order to insure an accurate count, methods must be specific for the nuclear material of the cells, which necessitates the use of a dichromatic, differential stain that stains nuclear material differently than cytoplasmic particles.

On July 1, 1985, NCIMS made the Pyronin-Y Methyl Green stain the official regulatory confirmation stain for use with the Direct Microscopic Somatic Cell Count (DMSCC) for goat milk. For regulatory purposes, cell counts of 1.5 million cells per ml or more from screening tests such as electronic cell counting must be confirmed with the Pyronin Y-Methyl Green DMSCC. It is necessary that the laboratory personnel performing these tests be trained in the use of Pyronin-Y Methyl Green stain. Refer to (DPC 075, Direct Microscopic Examination of Milk From Small Ruminant) for more information.

The second cell count issue relates to elevated cell counts in milk produced from udders free of disease-causing bacteria. Healthy, non-mastitic goats can produce milk with a somatic cell count of 1.0 million cells/ml and experience no decrease in milk yield and no change in milk components or milk quality. A research project, using biochemical analysis to study both cell competency and enzymatic influence as factors in the cause of elevated cell counts in normal goat milk was completed. It has shown that there is a clear difference in the milk from a goat with mastitis, and a late lactation goat with a high SCC but no mastitis.

The National Mastitis Council and the NCIMS recognized the need for a separate cell count standard for goat milk. Therefore, the goat milk standard remained at 1.0 million cells/ml when the milk standard for cattle was lowered to 750,000 cells/ml on July 1, 1993, and in 2009 the standard for goats was raised to 1,500,000 cells per ml.

The elevated cell count in goat milk is amplified in the fall since seasonal breeding results in many in the goat herd approaching late lactation at the same time and late lactation often results in an elevated count. Goat milk bulk tank somatic cell counts show a distinct seasonal variation with the lowest in April and the highest in September through October, reflecting the number of late lactation does. It is also important to remember that a high SCC in early lactation is a good indicator of an udder health problem and should be investigated.

For information on out of season breeding refer to DPC 076, Out of Season Breeding for Goats.

Antibiotic Residue Test



Abnormal milk and residues of antibiotics and pesticides are illegal in milk from either goats or cattle. Of immediate concern is the fact that few of the antibiotics approved for use in lactating cattle have been tested and approved for treating lactating goats. There are now rapid antibiotic residue tests available that have been tested using goat milk. Contact your local regulatory agency or milk handler for a current list of the approved tests.

Flavor and Odor

The test for flavor and odor does not require any special laboratory equipment. It is a matter of smelling the milk and developing the ability to detect the difference between good and bad milk. It is less quantitative than other tests and may only come into play when there are obvious problems. To perform this, test the milk is warmed to room temperature in a closed container. This will amplify any odors or flavors. The test should be done away from the barn or any strong odors. Raw milk should be pasteurized before flavoring to minimize risk from pathogens. Open the container near your nose so that you can smell the air coming from the container. It should only have a slight caprine smell. Take a small amount of the milk into your mouth and move it around to cover your entire tongue. This is important as different parts of your tongue sense different flavors. When tasting multiple samples do not swallow the milk as one bad sample may affect the next few. Expectorate the milk between samples and rinse your mouth with warm water after any unusual flavors.

Normal goat milk will have a clean taste, a slight caprine essence and a slightly different mouth feel than milk from cattle or sheep. This distinctive flavor and texture is normal, and desirable, in goat's milk. Consumers should be made aware that the unique chemical composition of goat milk gives rise to these expected, but minor, differences in the taste of goat milk and its products when compared to the better-known flavors and textures of similar products made with milk from cattle.

Milk characteristically has fat globules, which cause it to absorb environmental odors from feed or barn surroundings, and even though goat milk has smaller fat globules than those in milk from cattle the milk is still sensitive to absorbing odors. Off flavors can be prevented by the same care in production and handling that has long been shown to be effective in managing cattle operations. For more information refer to (DPC 038, Preventing Off- Flavors in Milk).

Lactose

Lactose in goat's milk can be tested using the same methodology as milk from cattle. The lactose content of goat's milk is about the same as the lactose content in milk from cattle Yet somehow, rumors seem to persist that goat milk has no lactose and therefore is good for people that are lactose intolerant. This is not true. It is true however, that some people who are fat intolerant of milk from cattle can readily digest goat's milk.

QUALITY CONTROL

Requirements for producing goat milk having desirable attributes of quality to meet consumer expectations are well known. Proper procedures to produce and handle milk assuring excellent quality have been developed and utilized in the dairy milk industry that has developed around cattle for many years. Essential components of a quality assurance program vary little between goat and cattle milking operations. Goat milk has been recognized by NCIMS as having a different compositional value than milk from cattle but the sanitary requirements of the PMO are the same for milk from both goats and cattle.

Basic procedures for desirable quality control of goat milk emphasize the importance of clean, sanitary practices and the avoidance of environmental contaminants from dust, silage, water, etc.



Milk contact surfaces must be properly cleaned after each use and sanitized prior to the next milking. Milk should be cooled quickly to 36 °-40°F (2.2°-4.4°C) and maintained at that temperature until and following pasteurization of the supply. It must be cooled to, and held between milkings, at or below 45°F (7.2°C) to meet legal requirements (Some states require 40°F (4.4°C)). Milk may be frozen to preserve raw milk for making cheese during periods when fresh goat milk is in short supply. However, some cheeses will be negatively affected by this practice. During transportation, goat milk should be kept refrigerated at temperatures above freezing but below 40°F (4.4°C).

Exposure of milk to room temperatures during mealtime or food preparation should be kept to a minimum, and milk should be returned to the refrigerator as quickly as possible. Exposure to natural or artificial light and long storage periods should be avoided.

MASTITIS

For more information refer to (DPC 072, Guide to High Somatic Cell Counts in Goats).

Mastitis is defined as an inflammation of the udder. The inflammation may stem from either injury to the udder or bacterial invasion of the udder or both. In clinical mastitis, the milk is obviously abnormal to sight and the animal may appear sick. In sub- clinical mastitis, the milk and the goat generally appear to be normal; however, the somatic cell count usually increases to above 1.5 million cells/ml.

The majority of goat mastitis is caused by Staphylococci, predominantly Staphylococcus epidermidis and Staphylococcus aureus. Staphylococcus epidermidis is a minor pathogen in dairy cattle and is characterized by a slight elevation in cell count. In goats, Staphylococcus epidermidis is a major pathogen resulting in elevated leucocyte counts and loss of milk production.

A small percentage of goat mastitis is caused by Streptococcus. Of the species of Streptococci causing mastitis the three most commonly found are: Streptococcus uberis, Streptococcus dysgalactiae and Streptococcus agalactiae.

In late lactation, a high percentage of mastitis in goats is nonspecific. In such cases, bacteria are not cultured, yet the cell count is over 1.5 million cells/ml.

PASTEURIZATION

"Raw goat milk" as well as milk from cattle should be pasteurized prior to human consumption to eliminate the many disease-producing microorganisms from human, animal, and environmental sources that may contaminate milk.

Dairy literature identifies a dozen or more human diseases traced to raw milk from goats and cattle. These include Brucellosis (Undulant Fever), Listeriosis, Tuberculosis, Campylobacteriosis, Yersinia and Staphylococcal food poisoning. The more recent recognition that some of these pathogens, especially Listeria and Yersinia, can multiply at refrigeration temperatures makes routine pasteurization all the more imperative if disease transmission and resulting liability decisions are to be avoided by the goat industry.

Pasteurization of goat milk is mandated for commercial sales in most states. Procedures defined in the PMO must be observed and qualified state regulatory agency personnel will routinely



inspect processing facilities. Some states allow licensed goat dairies to sell raw milk. These dairies must meet high quality standards to become licensed. Even in areas where limited sales of raw goat milk may be allowed, pasteurization of milk used in milk products is usually required to assure food safety. Pasteurization equipment is subject to state/federal approval and may be expensive for the small dairy operators. Many small "pasteurizers" capable of heat-treating a few quarts of milk are available for home use but are not accepted for commercial sales because they lack the necessary control and recording mechanisms. However, there are now small vat pasteurizers available in the United States, which have the approved type of controls and recording mechanisms. These have been designed for a few gallons to hundreds of gallons of capacity.

Raw milk used for some goat cheese production is legal if the cheese is allowed to age and is not sold until it has aged for 60 days. Check with your local regulatory authority.

Many goat dairies are heat-treating colostrum in an effort to control caprine arthritis encephalitis (CAE) in their goat herd.

MILKING SYSTEMS

For more detail refer to (DPC 070, Design, Installation and Cleaning of Small Ruminant Milking Systems).

Hand Milking

Many dairy goat farms have just a few animals and cannot justify much mechanization. These herds are often hand milked. Hand milking is a specialized technique in itself to properly milk the animal efficiently, and it is generally very gentle on the animal. It can be a physical stress on the producer if several animals are being milked. Further, it adds a few sanitary challenges since the bucket is constantly exposed to the elements during the milking process. It is recommended that goats be milked away from their bedded area to avoid manure and air contamination. The practice of wetting hands while hand milking is prohibited in the PMO as there is too high a risk of contaminating the milk. Hands, and the animal's teats, should be clean, treated with a disinfectant and dry prior to milking. Once an animal has been milked, the pail should be covered to prevent any contamination as it is carried to the milk house.

Generally, the animals are confined in an elevated stand for easier access as shown in Figure 1. When dairy goats are milked for commercial (milk is being sold) production, wooden stands are generally not acceptable. Check with your local regulatory authority. Regular hand washing is essential for the person milking to prevent contamination of the milk and to minimize the spread of mastitis causing organisms.

Machine Milking

When the herd numbers start to exceed 15 or 20 animals or the milker has physical limitations, a milking machine may be justified. This mechanically milks the goats as well as letting one operator milk 2 to 6 or more animals at once. The basic components of a milking machine system include:

Vacuum Pump - source of the vacuum

Pulsator Line - carries the vacuum to the pulsators

Vacuum Regulator - maintains an even level of vacuum



Vacuum Gauge - allows monitoring of the vacuum level

Trap - prevents moisture from entering the vacuum pump and prevents contamination of the sanitary system from the vacuum system

Distribution Tank - acts as a vacuum reserve and buffers vacuum changes

Claw - acts as a receptacle for the milk and is attached to the teat cups

Milking Cluster – the combination of the claw, teat cups, and the milk and pulsation hoses

Milking Bucket - attaches to one or two clusters and serves as a milk reservoir

Pipeline Milking System - a system where a sanitary milk line is transports milk, and concurrently vacuum, between the long milk tube of the milking cluster to the receiver.

Pulsator - maintains an even milk and rest ratio as part of the milking process. With goats the pulsators should run at a rate of 60 to 120 pulsations per minute (PPM) and a rest percentage of 50 to 70%. If pulsators designed for cattle are used, operate them at the speed they were designed to run.

Figure 1. Wood Goat Milk Stand for Home Protection

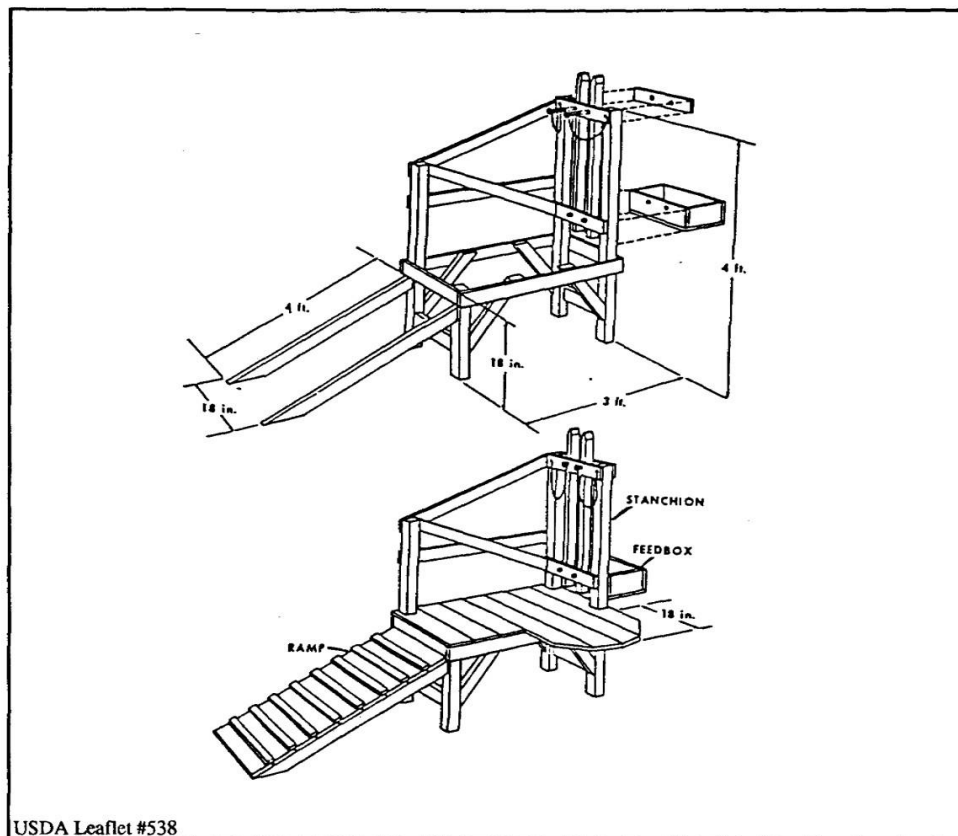


Table 1. Recommended Minimum Air Flow Requirements to Milk

Number of Units = n	Minimum Effective Reserve ^a			
	Pipeline		Buckets	
	CFM free air	l/min free air	CFM free air	l/min free air
Conventional Cluster without automatic shut-off valve				
n ≤ 10	7+(0.7*n) + 14 per operator	200 + (20*n) + 400 per operator	3.5+ (0.7*n)+ 7 per operator	100 + (20*n) + 200per operator
n > 10	14+0.35*(n-10) + 14 per operator	400 + 10*(n-10) 400 per operator	10.6+0.35*(n-10) + 7 per operator	300+10*(n-10)+ 200 per operator
a – Add the airflow required for any ancillary equipment such as vacuum dumping station, doors, etc				

The table above contains recommendations based on ANSI/ASABE5707 2007 updated in 2016 Informative Appendix D Table D1. Use the formula in the appropriate cell to calculate the minimum effect reserve needed. The standard is that you should be able to invert one unit(with any automatic shut-off disabled) and not lose more than 0.6 inches of mercury (2 kPa) with all of the units pulsating and ready to milk. For systems with more than 32 units you should be able to invert 2 units (per 5.2.4.4 ANSI/ASABE6690 2007 updated in 2016. For non-conventional clusters refer to ANSI/ASABE5707 2007 updated in 2016.

Along with their efficiencies, milking machines require more cleaning and set up time, as well as regular maintenance. Improper operation and cleaning of the equipment can result in mastitis and high bacteria counts.

Separate milking areas need to be provided for efficient layout of equipment and to ensure proper sanitation.

Every milking system should have a vacuum gauge installed on the vacuum line delivering vacuum to the buckets. With this gauge you can easily test the effectiveness of your vacuum pump. Milking systems should be capable of maintaining a stable vacuum. The vacuum gauge should vary less than 0.6 inches of mercury (2 kPa) from its normal setting under normal milking conditions.

A milking system with more than two buckets should be able to have one unit fall off, drawing air, and have the vacuum gauge vary less than 0.6 inches of mercury (2 kPa). To test the vacuum system, invert one milking unit with any shut-offs open or disabled. The vacuum should not drop more than 0.6 inches of mercury (2 kPa). While milking your animals, including while attaching the inflations to the goats, the gauge should not vary more than 0.6 inches of mercury (2 kPa) If it does, contact your equipment dealer to do a more detailed test of the system. Refer to Table 1 for a listing of vacuum requirements needed for a bucket milker.

Pipeline Milking System

A pipeline system further automates the bucket system. The milk is transported directly from the goat to the bulk tank by the system without manual handling of the milk. This requires an even greater capital investment.



Figure 2. Schematic of a Pipeline Milking System

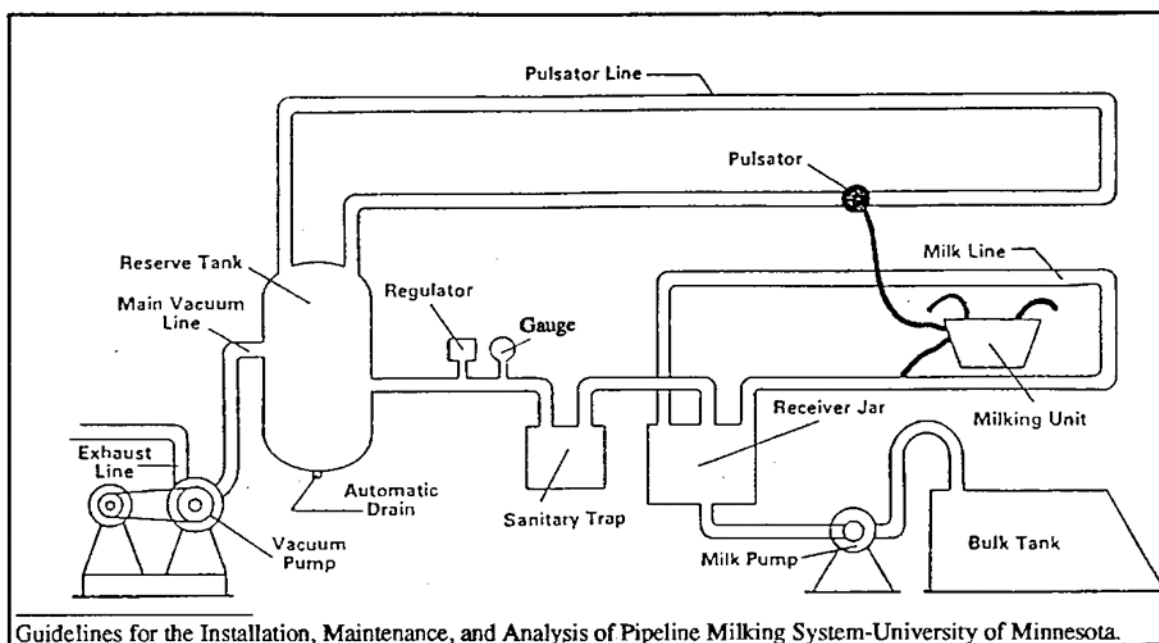
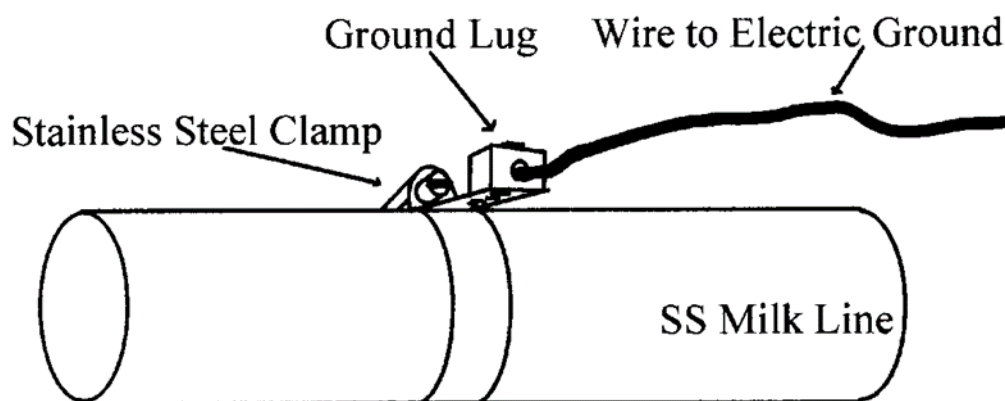


Figure 3. Example of Proper Electrical Bonding of Milk Line



The pipeline system has components similar to the bucket system; however, the bucket is eliminated and the milk flows directly into the pipeline that empties into a receptacle called a milk receiver. The receiver group is located either in the pit of a parlor or in the milk room. It contains a device that senses the level of the milk and it activates a centrifugal pump to discharge the milk into the bulk tank. Refer to the schematic layout in Figure 2.)

As with bucket systems all pipeline milking system should have a vacuum gauge. The gauge should be installed on the vacuum line delivering vacuum to the sanitary trap (refer to Figure 2). With this gauge you can easily test the effectiveness of your vacuum pump. Milking systems should be capable of maintaining a stable vacuum. The vacuum gauge should vary less than 0.6 inches of mercury (2 kPa) from its normal setting under normal milking conditions.

A pipeline milking system should be able to have one unit fall off, drawing air, and have the vacuum gauge vary less than 0.6 inches of mercury (2 kPa). To test the vacuum system invert one milking unit with any shut-offs open or disabled. The vacuum should not drop more than 0.6 inches of mercury (2 kPa). While milking your animals, including while attaching the inflations to the goats, the gauge should not vary more than 0.6 inches of mercury (2Kpa). If it does, contact your equipment dealer to do a more detailed test of the system. Refer to Tables 2 and 3 for a listing of vacuum requirements needed for pipeline milking systems.

The pipeline system is set up for mechanical washing and is installed in conjunction with a wash sink. An air injector is needed to add a surge action to the water to assist in cleaning. Pipeline systems have a large vacuum requirement because of the additional demands of moving milk and especially during cleaning. A general rule of thumb is that a vacuum pump will deliver 10 cfm (ASME) per horsepower.

For electrical safety, the milk line, vacuum lines and parlor stalls, if metallic, should be bonded to the electrical grounding system. When bonding stainless steel, you must not connect the copper wire directly to the milk line. Refer to Figure 3.

When using milking machines, make sure that they are well maintained, with inflations being changed every 1,200 milkings for standard inflations (or as specified by the manufacturer) or by 120-150 days, whichever comes first.

For example, if there are three milking machine units used on 60 goats:

60 goats / 3 units = 20 milkings per unit per milking or 40 milkings per day

If your inflations are good for 1,200 milkings: divide 1200 by the 40 milkings /day to get 30.

In this example the inflations should be changed every 30 days.

NOTE: The faster pulsation may reduce inflation life slightly as will the number of washings. If you only milk a few animals each day do not expect your inflations to last 1,200 milkings. Talk this over with your supplier. At a minimum you will need to change them each year. A good rule of thumb is that if you notice a difference in animal milk out when you replace the inflations you should change them more often or you may experience a cleaning problem. 1.5" diameter pipelines for milking are not recommended for cattle systems but can be used for dairy goat operations.

A pipeline system may run in a circuit around the barn and over the animals if they are housed in stanchions, but more commonly separate milking parlors are used for dairy goats. A parlor pipeline can be set up as a high line or low line; however, in either case, the line must slope 1" per 10' toward the receiver area. A high line has the milk line above the animals and the milk has to be lifted a maximum of 7' to enter the system. This is often used if there are structural limitations in the building. For more detail refer to (DPC 070, Design, Installation and Cleaning of Small Ruminant Milking Systems).



Vacuum Requirements

Table 2. Vacuum Level Requirements

Vacuum Level	Inches of Mercury ("Hg)	Kilopascal (kPa)
High Line	13 – 14	44 – 48
Low Line	11 – 12.5	38 – 42
Mid Line	12 – 13.5	41 – 46
Recommended claw vacuum at peak flow rate of 10 to 12 inches of mercury of 35 - 41 kPa		

Table 3. Minimum Air Flow (ASME) for Washing

Inches	MM	CFM/ASME	Liters/minute
1.5	36	25	700
2.0	48	40	1120
2.5	60	60	1680

Units per slope:

To maintain stratified flow in a pipeline milking system there are a number of factors that need to be considered. The primary ones are milk flow rate, air flow from the air bleeds on the milking cluster, cluster type, air flow from unit attachment, how fast the units are attached, the peak flow rate of the animals being milked, and the duration of milk let down. Table 3 uses the assumptions noted below. If an installer wishes to vary one of the assumptions, they should refer to ANSI/ASABE5707 2007: Update 2016 for the formula or Table needed to calculate the proper number of units per slope. The assumptions in the chart are for the highest anticipated flow and attachment rates with conventional milking cluster. Attachment rates significantly affect the calculations. If multiple operators are attaching simultaneously less units per slope should be recommended. In the US the preferred slopes are 1.0% to 1.2%.



Table 4. Guidelines to Assure Stratified Flow in Looped Milklines

Nominal Line Size		1" Per 10'		1.5" Per 10'(1.0%)		1.75" per 10'(1.5%)	
Milking duration		< 2 minutes	> 2 minutes	< 2 minutes	> 2 minutes	< 2 minutes	> 2 minutes
1.5" (36mm)	Low Flow Breeds	3	3	3	3	5	5
1.5" (36mm)	High Flow Breeds	2	2	2	2	3	2
2" (48mm)	Low Flow Breeds	9	8	11	10	a	13
2" (48mm)	High Flow Breeds	6	5	9	6	a	8
2.5" (60mm)	Low Flow Breeds	a	18	a	22	a	a
2.5" (60mm)	High Flow Breeds	9	12	a	16	a	22
3" (73mm)	Low Flow Breeds	a	a	a	a	a	a
3" (73mm)	High Flow Breeds	a	34	a	a	a	a

Assumptions:

- Attachment rate of 5 seconds per unit
- Goats and some sheep will typically take longer than 2 minutes to milk
- Sheep typically take less than 2 minutes to milk
- Operators careful to admit very little air during attachment.
- Low flow is 1.8 lbs. /min (0.8 kg/min)
- High flow is 2.9 lbs. /min (1.3 kg/min)

a – With the attachment rate stated there is no limit to the number of units per slope as animals will be done milking as more are attached. Multiple operators would need a larger line.

The above sizing chart is for lines concurrently carrying milk and the milking vacuum; lines only conveying milk are sized, as recommended by the manufacturers, so that no significant damage to the milk occurs.

A low line system is preferred because lifting milk to a high line is conducive to an increased incidence of rancid flavor and vacuum fluctuations. (For more information refer to (DPC 038, Preventing Off- Flavors in Milk). The milkline forms a loop around the lower walls of the parlor and the milk enters at a level lower than where the animal stands. This makes better use of gravity, which results in a smoother flow of milk. Table 4 shows the proper line sizes needed based on the number of milking units per slope.

TYPES OF MILKING PARLORS

In a commercial operation, all milking parlor floors, and elevated stands must be constructed of concrete, tile, metal or some other type of impervious material. The use of wood is prohibited in many states and is strongly discouraged as it is very hard to maintain the surfaces as non-impervious. Paint does not hold up well in wet environments. The types of parlors listed below can be set up as pits, or the stalls may be elevated so that the operator can operate at waist level and the goats climb an elevated ramp to enter.



Herringbone Parlor

The herringbone parlor is commonly used with dairy cattle. There is a pit in the middle, so the animals stand elevated to the operator at a 30° to 40° angles on both sides for easy access to the udder. With goats, there could be a problem in properly positioning them and the short length of the animal might make the angle less of an advantage. The pit is usually about 5' to 6' wide, and the depth needs to be custom designed to the comfort of the operator to avoid bending, but often varies between 36"-40" deep.

The animals enter and exit as a group, which makes efficient animal handling. However, a slow milking animal will detain the whole string. For efficient traffic flow, there should be a holding area outside the parlor to hold animals close to the entrance, and a well-defined exit alley to direct the animals back to the barn.

Straight-Through Parlor

A straight-through parlor is similar to the herringbone, but the animals do not stand at an angle to the operator. They are lined up head to tail and enter and exit as a group. This makes positioning easier and the distance from udder to udder is minimal, which provides for efficient handling of the milking unit.

Parallel Parlor

In the parallel parlor, the animals are elevated above the pit and stand parallel to one another facing away from the operator on both sides of the pit. Only the rear udder is accessible which is convenient but could be a problem for goats with non-symmetrical teat placement. The pit dimensions are similar to those outlined previously for the herringbone parlor, but it is sometimes deeper for easier access to the udder. With the animals standing parallel, more animals can fit in a space than a herringbone. However, additional space is needed in front of the animals as they can exit off to the side by lifting the restraining bar. Provision needs to be made for collecting the urine and manure to deflect it from the milking area.

Side-Opening Parlor

The side-opening parlor is another option for dairy goat operations. There is a pit similar to the ones described previously, but the goats stand in individual stall units, which run parallel to the pit, with the animals in a line head to tail. The animals can enter and exit at their own pace and not affect the rest of the animals. While individual stalls help in handling each goat as a separate unit, they do create more opening and closing of gates and there is a greater distance to walk from one milking unit to the next.

Rotary Parlor

The rotary parlor can be more expensive and may add some additional animal handling considerations to properly channel the animals onto the rotating parlor. These are set up for either the operator to be inside the pit with the animals rotating around them on a circular platform facing out; or the animals face the center of the circle and the platform rotates by the operators who work along the outside circumference. These are mechanically propelled at a slow speed to keep the animals progressing around the circle to the exit as they complete milking. This type of parlor is more suited for large operations.

Elevated Stands



To save money in construction, a milking parlor can be set up with just elevated milking stands with a pipeline mounted overhead. The stands are set up in a separate milking area and must be made of impervious material, such as concrete or steel for easy cleaning. The goat can enter the parlor and jump up onto the stand and the milking unit can be attached from the side or rear. This system doesn't eliminate the bending associated with milking and animal movement isn't as efficient as a parlor pit arrangement.

Parlor Mechanization

There is a wide variety of equipment available that can be installed to mechanize a milking parlor operated on a large commercial scale. Some of these include:

Automatic detachers - these units sense the milk flow and shut off the vacuum and remove the unit when milking is complete. There can be a flexible arm or a retractable cord, depending upon which type better fits the parlor design.

Movable holding area gates - or crowd gate can be electronically controlled to advance forward and keep the animals confined to a smaller area and encourage them to enter the parlor.

Power gates and doors - power-operated entrance and exit doors can be opened and closed with pneumatic cylinders. This saves pulling ropes and having to walk from one end of the parlor to the other to open and close doors.

Feed gates and feed bowl covers - these can be used in a parlor to prevent animals from stopping and eating as they walk past feed in the mangers.

Covers or gates can open in sequence as animals enter or close in sequence as they exit the parlor.

Milk meters and recorders - electronic and mechanical flow-through meters are available to record milk production on each animal. The data can be manually or electronically recorded and compiled to assist in herd management decisions.

Milking Parlor Construction

The milking parlor should be a separate room, but readily accessible to both the milkroom and animal housing area. Based on climate and conditions, consideration needs to be given to provide adequate drainage and proper joining of rooflines to maintain the slope needed to minimize snow loads.

Milking parlors are humid areas due to the number of animals in the confined space and the amount of water used in cleaning. Construction materials and methods need to take this into account.

Below are a few key points:

There should be an 18" high concrete base wall to prevent rotting of the sills.

Wood frame walls are recommended above the concrete, insulated to R-19.

Inside wall and ceiling surfaces should be water resistant, cleanable, and smooth. Well-sealed fiberglass or plastic board is preferable to paint.

Floors need to be relatively smooth for cleaning but have enough texture to prevent slipping.



Floors should be sloped in one direction to drains, located at the end in the corners or sloped to a grate type drain.

Lighting should illuminate the area properly for milking.

Ventilation and fresh air inlets should be provided for worker comfort and to minimize the chance of odors getting into the milk.

Utilities need to be planned to handle the commercial demands.

MILKING PROCEDURES

In order to produce quality milk, attention needs to be focused on sanitation details. Milk processing can never make milk any better than when it leaves the farm. Milking procedures have a big impact on milk quality and udder health.

If the udders are relatively clean, pre-dips are recommended. This prevents getting a lot of water on the udder, which can spread mastitis or contaminate the milk. These dips are applied and allowed to sit 30 seconds and then wiped off. If washing is necessary, use an udder disinfectant solution and wash with individual paper towels. Properly dispose of soiled towels after each animal is prepped. Then, adequately dry the udder with another disposable towel.

The back two pages of this Guideline is a two-page summary of a good milking procedure that can be copied or removed and placed in the milking areas.

It is advisable to check the foremilk of the animal before milking. This should be done before the final prepping of the udder is completed to avoid contamination of the teat. Some milkers check before pre-dipping or while the dip is still on and hasn't been wiped off. To prevent the possible spread of organisms by the hands and to reduce skin irritation, milkers may wear disposable plastic gloves during the milking process.

Milking

For more detail see (DPC 072, Guide Somatic Cell Counts in Goats).

If hand milking, be sure hands are clean, dry and have been treated with a disinfectant. Use a gentle squeezing action, letting the fingers follow the flow of milk from the teat. Don't pull or excessively squeeze the teats and maintain an even rhythm of milking. Hold the open pail in such a way to protect it from any debris while milking.

Following are a few guidelines to follow when milking by machine:

- Don't let a lot of air in when putting inflations on the teat. Bend the inflation sharply to cut off air leakage until lined up with the teat.
- Properly adjust the unit on the goat so she milks out evenly.
- Don't do a lot of massaging of the udder during milking, as it will get the animals dependent on this action to let down the milk.
- Remove units when constant milk flow has ceased. Don't try to get every last drop; there will always be a little left. Shut off the vacuum and then allow the vacuum to bleed off through the air vents before removing the unit.



Post Milking Disinfection

The use of a post milking disinfectant (teat dip) will help prevent mastitis infection by sanitizing the teat end. Try to release the goats to a feed area to encourage them to stay on their feet and eat since the teat orifices are still relaxed after milking and activity prevents the animals from lying in bedding which might contaminate the teat ends.

The last two pages of the guideline can be removed or copied to put in the milking area as a milking procedure reference.

Cleaning Milking Equipment

Immediately after each milking, the milking equipment should first be rinsed with tepid water. Then this should be followed by washing with hot water and a dairy detergent, followed by an acid rinse, and then sanitized prior to the next milking. These procedures will vary between pipeline and bucket milking systems. For more information refer to (DPC 070, Design, Installation and Cleaning of Small Ruminants Milking Systems) and (DPC 009, Fundamentals of Cleaning and Sanitizing Farm Milk Handling Systems).

Milkroom

Dairy goat operations making milk only for their own family members often make use of the family's kitchen for handling milk and cleaning the equipment. However, commercial dairies are required to have a milkroom and fall under regulatory authority.

The milkroom must meet strict regulatory requirements set by federal and state public health agencies. Refer to (DPC 073, Layout of Small Dairy Milkhouses) and (DPC 041, Guidelines for Milkrooms and Bulk Tank Installations).

Some basic requirements are:

- A milkhouse or room of sufficient size shall be provided, in which the cooling, handling, and storing of milk and the washing, sanitizing, and storing of milk containers and utensils shall be conducted.
- The milkhouse shall be used for no other purpose than milkhouse operations.
- Only articles directly related to milkroom activities shall be permitted in the milkroom.
- The milkroom shall be free of trash, animals and fowl.

Some of the basic components of a milkroom include:

- Smooth impervious floor with a drain
- Insulated walls, with a smooth, cleanable surface
- A two compartment wash sink, and a hand sink Running hot and cold water
- Adequate space for a bulk tank with approved clearance distances on all sides



- Proper ventilation for milk cooling units Self-closing doors
- Adequate electric service for lights and operating electric motors

It is advisable to put some of the auxiliary equipment in a separately partitioned utility room. This provides a good place for storage and makes it easier to keep the main milkroom sanitary.

On a small scale, using the household septic system may work to take care of wastewater involved in cleaning and sanitizing dairy equipment. However, on a larger scale, wastewater laden with milk proteins and fats will clog a household system and cause permanent damage. The milkroom should have its own waste disposal system. Generally, there is greater success in handling it above the ground surface than below because the properties of milk cause it to saturate leach fields and make them impermeable.

One possible option for goat dairies is to utilize, in climates that permit is a grass filter bed system. This disperses the milkroom waste over a wide grass sod area and allows for both evaporation and absorption. (For more information refer to (DPC 015, Milking Center Waste Water).

CONCLUSIONS

Sanitation cannot be overemphasized when making quality goat milk. Clean animals, proper nutrition, and adequate facilities create the environment for making quality milk. Adequate equipment and the use of proper milking procedures are necessary to ensure a quality product. Remember commercial goat dairies require site and plan approval prior to the start of any construction by the Regulatory Agency. This would include the pipeline system and equipment.

REFERENCES

- DPC 009, Fundamentals of Cleaning and Sanitizing Farm Milk Handling Systems
- DPC 015 Milking Center Waste Water
- DPC 024, Troubleshooting High Bacteria Counts of Raw Milk
- DPC 038, Preventing Off-Flavors in Milk
- DPC 041, Guidelines for Milkrooms and Bulk Tank Installations
- DPC 070, Design, Installation and Cleaning of Small Ruminant Milking Systems
- DPC 072, Guide to High Somatic Cell Counts in Goats
- DPC 073, Layout of Small Dairy Milkhouses
- DPC 075, Direct Microscopic Examination of Milk from Small Ruminants
- DPC 076, Out of Season Breeding for Goats

APPENDIX

Procedural Reference Sheet below can be printed and displayed in milking area.



Milking Procedure Using Predipping

- A. Clean Teats As Necessary**
- B. Completely Coat Each Teat To The Base Of The Udder With an Effective Teat Disinfectant**
- C. Observe The Foremilk (may be done before predipping--see discussion on back)**
- D. Wipe Dry With Individual Towel**
- E. Attach Unit or Hand Milk**
- F. Adjust Unit to Minimize Liner Slip**
- G. Shut Off Vacuum, Then Remove Unit**
- H. Coat Teat With Post Milking Sanitizer**



For More Details Read Reverse Side

Explanation of Milking Procedure

Please post this in the milkhouse or milking parlor for review by personnel as needed.

- A. If teats are visibly soiled, wash them with an individual towel wetted with a sanitizing solution compatible with your teat disinfectant. **24 hour hygiene is essential for good milk quality.**
- B. Completely **coat** the teat to the base of the udder with a teat disinfectant. Use a product that is labeled as a predip and has been shown to be effective at preventing IMI*. **Be sure to cover the entire teat** and allow for at least a 30 second contact time.
- C. **Observe** the foremilk from each teat for abnormalities. **Do not strip milk into your hand. Note:** If you check foremilk before predipping, be sure to attach the unit within 1 minute to maximize milk let down. Milking gloves are available and may aid in preventing the spread of mastitis.
- D. **Dry** teats thoroughly with individual paper towels to remove all the teat disinfectant to prevent residues. If predip has dried, recoat, and remove while wet. **When machine milking, do not touch teats with your hands after removing the teat disinfectant.**
- E. **Attach** the milker unit between 1/2 and 1 minute after the start of udder stimulation. Or, **Hand Milk** with clean, dry hands. Wet hand milking is prohibited in the PMO.
- F. **Adjust** unit as necessary for proper alignment to prevent 'squawks' (liner slips) and air admission, especially at the end of milking when the slightest 'squawk' may increase the risk of new IMI.
- G. **Shut off** vacuum before removing unit.
- H. Immediately after unit removal **coat each teat** with an effective teat disinfectant that has been shown to be effective at preventing new IMI*.

Cautions:

- **When using a predip or spray, coating the entire teat is highly recommended.**
- **If recirculating dip cups are used, discard used teat disinfectant and wash the dip container after each milking.**
- **In freezing weather be sure liquid post teat disinfectant has dried or has been removed before allowing goats to go outdoors into cold temperatures.**

*Effectiveness can be shown through research protocols recommended by The National Mastitis Council. Split herd or split udder studies done under experimental challenge or natural exposure have shown themselves to be reliable ways of determining efficacy of teat disinfectants to prevent new intramammary infections (IMI).



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