

Choosing an Animal

Starting Your Project

There are several ways to start your goat project. First, you need to decide what type of goat project that you want to do—meat, dairy, fiber, pygmy, or utility (harness or pack). You can select an animal or animals from your parents or your own herd, or you can purchase from an established goat producer in your area.

When purchasing an animal, decide the goals for your project before you make your final decision. Selection of an animal depends on your project goals, as well as on what breed, size, and quality of animals you would like. For more information on breeds, read the section Breeds of Goats later in this chapter.

Once you have chosen the breed, you need to select either registered or grade animals. Registered animals are usually purebred and cost more than grade. Dairy goat breeds can also be “recorded grade.” If you want to get involved with showing goats, then a registered or recorded-grade animal may be the right choice. If you are more interested in production than in showing, a grade animal (whether it is meat, dairy, fiber, pygmy, or utility) with correct body type and high production may produce better with good nutrition and management than a registered or recorded-grade goat. For the beginner who is learning about feeding, management, health, etc., good quality goats bought at a modest price may be the wisest investment. Purchasing livestock at high

prices does not guarantee success, nor does it mean easier management.

This handbook provides the information you need to select good quality goats. In this chapter, you will learn the characteristics of size and conformation that indicate good quality. But first, it is helpful to learn some history, to be able to identify the most common breeds of goats, and to learn the parts of a goat.

History of Goats

The goat or *Capra hircus* is thought to be one of the first domesticated animals. Goat skeletal remains have been found at archeological sites dating back 10,000 years. These goats were thought to have been a source of meat and milk. Today's European goats descended from the Bezoar goat, which currently lives in the Greek Islands, Turkey, and Pakistan. Goats are found on every continent and in all parts of the world, except for the Arctic. They are a very important part of some cultures. There are more than 300 breeds of goats, although not all of those are recognized as registered breeds. The Toggenburg, a dairy goat breed, is the oldest known registered breed in the world.

Goats were often taken on early voyages as a meat and milk source. Early settlers to America brought goats over on the Mayflower. Most goat breeds entered North America from the 1500s to the 1700s and were of Swiss origin. Smaller numbers of



Spanish and Austrian goats were also in North America at that time. In 1904, the first dairy goat show was held in America at the World's Fair in St. Louis, Missouri. Also in 1904, the American Milk Goat Record Association was formed in Elyria, Ohio. Shortly thereafter, the association moved to North Carolina where it is currently located. In 1965, the name was changed to the American Dairy Goat Association (ADGA).

Today, goats provide a wide variety of products. They are important parts of the agriculture of many countries. Goat milk has a different fatty acid and protein structure than doe milk, and this often makes it easier for some people to digest. Individuals who are allergic to doe milk are commonly able to drink goat milk. Large parts of the world's population regularly drink goat versus doe milk. Worldwide, goat meat is consumed more than any other red meat and is a staple in many countries for festivals and holidays. Goats also provide two types of fiber—mohair and cashmere.

Breeds of Goats

Dairy Goats

The following descriptions have been adapted in part from the ADGA Breed Standards (<http://adga.org/breedstandards.html>) and from the Dairy Herd Improvement Registry (DHIR) (http://adga.org/DHIR/05breed_lactation_averages.htm).

There are six breeds of dairy goats commonly found in the United States. These are the Alpine, LaMancha, Nubian, Oberhasli, Saanen, and Toggenburg. In 2005, two less common breeds, the Sable and the Nigerian Dwarf, were admitted into ADGA.

Alpine



Courtesy of Curriculum Materials Service, The Ohio State University.
Special thanks to Willow Run Dairy.

The Alpine can be called either the French Alpine or the American Alpine, depending on parentage. However, when registered with ADGA, they are both referred to simply as Alpine. Alpines are a medium to large animal, have upright ears, medium to short hair, and a straight face. A Roman nose, Toggenburg color and markings, or an all white coat is discriminated against in the Alpine breed. Erect, medium-sized ears are preferred.

Alpines originated in the Alps region and are a fairly large and rangy goat. While no distinct color patterns have been bred for, there are typical color patterns that occur in the breed. Terms that describe the Alpine colors are as follows:

- Cou Blanc—Literally “white neck”; a white neck with black hindquarters and black or gray markings on the head.
- Cou Clair—Literally “clear neck”; a tan, saffron, off-white, or gray neck with black hindquarters.
- Cou Noir—Literally “black neck”; a black neck and front quarters with white hindquarters.



- Sundgau—Black with white markings on the underbody, facial stripes, and leg stripes, etc.
- Pied—Spotted or mottled in coloring.
- Chamoisee—Brown or bay with characteristic markings of a black face, dorsal stripe, feet and legs, and sometimes a martingale running over the withers and down the chest.
- Two-Tone Chamoisee—Light front quarters with brown or gray hindquarters. These animals are not Cou Blanc or Cou Clair as those animals have black hindquarters.
- Broken Chamoisee—A solid chamoisee color, broken by another color (usually white) by being banded or splashed.

Any variations in the above patterns broken with white should be described as a broken pattern, such as a broken Cou Blanc.

Alpines are known for being excellent milkers, with large, well-shaped udders. Alpines does should be at least 30 inches tall and weigh at least 135 pounds, while bucks must stand 32 inches tall and weigh a minimum of 170 pounds. According to ADGA and DHI, Alpines in 2005 averaged 2,334 pounds of milk, 3.3 percent milk fat, and 2.9 percent protein.

LaMancha

The LaMancha is the only dairy goat that was developed in the United States. LaManchas are medium-sized animals, with any color combination acceptable. The hair is short and fine. The distinctive characteristic of the LaMancha is its very small ears. The history of the LaMancha is not well known. Short-eared goats are found throughout history and are thought to have originated in the United States from some goats that the Spanish missionaries brought to California.



Courtesy of Curriculum Materials Service, The Ohio State University.
Special thanks to Willow Run Dairy.

Two individuals seem to be responsible for developing the American LaMancha as it is seen today. The name LaMancha supposedly comes from a group of short-eared goats that were sent to the 1904 World's Fair in Paris for exhibition. The crate they were in was labeled "LaMancha, Cordoba, Spain." The name LaMancha was kept for these short-eared goats.

While Phoebe Wilhelm was supposedly the first to own a herd of 125 LaManchas in the early 1920s, Mrs. Eula Fay Frey from Oregon was very instrumental in developing today's LaMancha from some short-eared goats that were in a herd that she bought. She was amazed by how much milk these smaller animals produced. She bred these short-eared animals to Nubian and French Alpines and got short-eared offspring that were excellent milkers. She further developed the breed, and LaManchas were accepted as a breed into the ADGA registry on January 27, 1958, with Fay's Ernie, L-1. Approximately 200 animals were entered into the herd book at that time.

LaManchas have two types of ears—the "gopher ear" and the "elf ear." Gopher ears preferably have very little to no cartilage,



with a maximum length of 1 inch (2.5 cm). The end of the ear must be turned up or down. Bucks, or male goats, must have a gopher ear to be eligible for registration. The other type of ear is the “elf ear.” Elf ears are a maximum of 2 inches (5.0 cm) in length and the end of the ear must turn up or down. Bucks with elf ears are ineligible for registration.

Mature LaMancha does, or females, should stand 28 inches tall and weigh 130 pounds, while bucks should stand 30 inches tall and weigh a minimum of 160 pounds. According to ADGA and DHI, LaManchas in 2005 averaged 2,050 pounds of milk, 3.9 percent milk fat, and 3.1 percent protein.

Nubian



Courtesy of Curriculum Materials Service, The Ohio State University.
Special thanks to Willow Run Dairy.

The Nubian is also called the Anglo-Nubian outside of the United States. It originated in England where bucks from the Nubia region of Africa and India were crossed with English does sometime around 1895. The Nubian is a large animal and is more heavily muscled than the other dairy breeds. This heavier muscling lends the Nubian breed to also being marketable as a meat goat.

Nubians are characterized by their long pendulous ears that must extend 1 inch past the end of their muzzle, a Roman nose, and short, fine hair. They are well suited for hot weather conditions. Any color or color pattern is acceptable in the Nubian breed. Their milk is known for its higher milk fat and protein concentrations compared to the other dairy breeds; however, their milk production is usually lower.

Mature Nubian does should be at least 30 inches tall and weigh 135 pounds. Nubian bucks should be at least 32 inches tall and weigh at least 170 pounds. According to ADGA and DHI, Nubians in 2005 averaged 1,754 pounds of milk, 4.8 percent milk fat, and 3.7 percent protein.

Oberhasli



Courtesy of Curriculum Materials Service, The Ohio State University.
Special thanks to Willow Run Dairy.

The Oberhasli breed is of Swiss origin and is a medium-sized animal. They are from the Briener region of Switzerland and are also known as the Oberhasli-Briener. When these animals were first imported to the United States in 1906 and again in 1920, they were called Swiss Alpines and were placed into the Alpine registry. In 1936, another group was imported to the



United States. Today's Oberhaslis come from the 1936 imports. A small group of dedicated breeders were determined to keep the Oberhasli as a pure breed and petitioned ADGA for its own herd book. In 1979, ADGA voted to make the Oberhasli its own breed, with its own herd book.

The Oberhasli differ from the Alpines in that they are slightly smaller in stature and more compact. They are characterized by their coloring, which is chamoisee. The females may be black, but the chamoisee coloring is preferred. The ADGA describes the standard coloring, called bay, as ranging from light to a deep red bay with the latter most desirable. A few white hairs through the coat and about the ears are permitted. Markings should include two black stripes down the face from above each eye to a black muzzle, a forehead that is nearly all black, black stripes from the base of each ear coming to a point just back of the poll and continuing along the neck and back as a dorsal stripe to the tail, a black belly and light tray to black udder, black legs below the knees and hocks, and ears that are black on the inside and bay on the outside. Bucks often have more black on the head than does, black whiskers, and black hair along the shoulder and lower chest with a mantle of black along the back. Bucks frequently have more white hairs throughout the coat than does. The face should be straight, as a Roman nose is discriminated against in the breed.

Mature height for an Oberhasli doe is 28 inches or more, and the mature weight should be near 120 pounds. Mature Oberhasli bucks must stand 30 inches tall and weigh 150 pounds. According to ADGA and DHI, the Oberhasli breed in 2005 averaged 2,137 pounds of milk, 3.4 percent milk fat, and 2.8 percent protein.

Saanen



Courtesy of Curriculum Materials Service, The Ohio State University.
Special thanks to Willow Run Dairy.

Saanens originated in the Saanen Valley of Switzerland. Saanens are the largest of all the dairy breeds. Saanen coat color is either white or cream, with white being preferred. Spots on the skin are allowed and are actually common; however, spots on the hair coat are discouraged. The hair is short and fine and the face is straight or dished, with ears erect. Because of their light coloring, they are sensitive to sunlight and can sunburn easy. They tend to not perform as well in hot weather and prefer colder climates. Saanens have the highest milk production of all the dairy goat breeds, which has given them the nickname of "Queen of the Dairy Goats."

Approximately 150 Saanens were imported between 1904 and the early 1930s from Switzerland. More Saanens came from England at a later date. Mature Saanen does should be at least 30 inches tall and weigh 135 pounds. The minimum height for mature bucks is 32 inches and 170 pounds. According to ADGA and DHI, the Saanen breed in 2005 averaged 2,537 pounds of milk, 3.3 percent milk fat, and 2.9 percent protein.



Toggenburg



Courtesy of Curriculum Materials Service, The Ohio State University.
Special thanks to Willow Run Dairy.

The Toggenburg originated in the Toggenburg Valley of Switzerland. It is the smallest and most compact of all the dairy breeds. Toggenburgs are a light fawn to a chocolate color with white markings. Their ears are white with a dark spot in the middle, and they have two white stripes down the face from above each eye to the muzzle. The hind legs are white from the hocks to the hooves, and the forelegs are white from the knees downward, with a dark vertical stripe below the knee being acceptable. They have a white triangle on either side of the tail, and white spots may be present at the root of the wattles or in the area where the wattles would be. The markings should be a light cream color, but white is the desired color. The ears are erect and carried straight forward, while the face is dished. As with the other breeds, except Nubian, a Roman nose is unacceptable. Toggenburgs have the longest hair of any of the dairy breeds, and it should be soft and very fine.

The Toggenburg is the smallest of the dairy breeds, with mature height for does being at least 26 inches. They should weigh 120 pounds. Mature bucks should be at least 28 inches tall with a minimum weight of 150

pounds. According to 2005 ADGA and DHI records, the Toggenburg breed averaged 2,101 pounds of milk, 3.3 percent milk fat, and 2.8 percent milk protein.

Sable



Courtesy of International Sable Breeders Association.

The Sable is an animal of Saanen breeding that is not white. In Saanens, the gene for the white coat is dominant and a colored coat is recessive. When an animal of Saanen breeding is colored, it is because it has two recessive genes paired for hair coat color. When two Saanens with the recessive gene for hair color are mated, 25 percent of the offspring are likely to be colored. Colored Saanens are NOT eligible for registry in the Saanen herd book; however, they are eligible for registering in the Sable herd book. To register an animal in the Sable herd book, proof of Saanen, Sable, or Sable/Saanen parentage must be provided. Any color pattern for Sables is acceptable except solid white and solid light cream, and Toggenburg color is discouraged. Mature does must be at least 30 inches tall at the withers and weigh 135 pounds. Mature bucks must be at least 32 inches tall at the withers and weigh 170 pounds. The hair is short. The ears are erect and alertly carried, pointing forward. The face should be straight or dished.



Nigerian Dwarf



Courtesy of Prairie Wood Ranch.

The Nigerian Dwarf is a small goat breed from Western Africa that has been developed for milk production more than for meat production. This goat is much smaller than the standard dairy goat breeds, standing 17 to 20 inches at the withers. Originally kept by African villagers to supply milk, these goats produce approximately 1 quart of high fat milk per day for up to 10 months.

The Nigerian Dwarf was imported to the United States in the 1980s, primarily to be exhibited at zoos and to be kept as pets. Their popularity grew due to their small size, ease of handling, and level of milk production.

The Nigerian Dwarf breeds at any time of the year and, therefore, can produce more than one kid crop per year. The doe should weigh 30 to 50 pounds, with a maximum height of 22.5 inches. The mature weight for a buck is 35 to 60 pounds, with a maximum height of 23.5 inches. Animals that are less than 17 inches tall at a mature age are discriminated against. The main colors of Nigerian Dwarfs are black, brown, or gold, with white markings. The Pygmy coloring, known as agouti, is discriminated against.

The Nigerian Dwarf produces approximately 2 to 4 pounds of milk per day, with

anywhere from 6 to 10 percent fat and 5 percent protein. These milk fat and protein concentrations are much higher than for the other dairy breeds, but remember, the Nigerian Dwarf produces much less milk overall. According to ADGA and DHI, the 2005 lactation average for the Nigerian Dwarf breed was 881 pounds of milk, with 6.5 percent fat and 4.0 percent protein.

Meat Goats

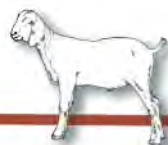
Any breed of goat can be used for meat, and every goat should be looked at as a potential meat source. However, there are breeds that are more suited for meat production than others. This is usually because these breeds have been selected to produce bigger, heavier muscled, and leaner carcasses than other breeds. Several breeds commonly used for meat in the United States include Boer, Kiko, and Spanish goats. Often, the larger dairy breeds, such as Nubian, Alpine, and Saanen, are crossed with meat goats.

Boer

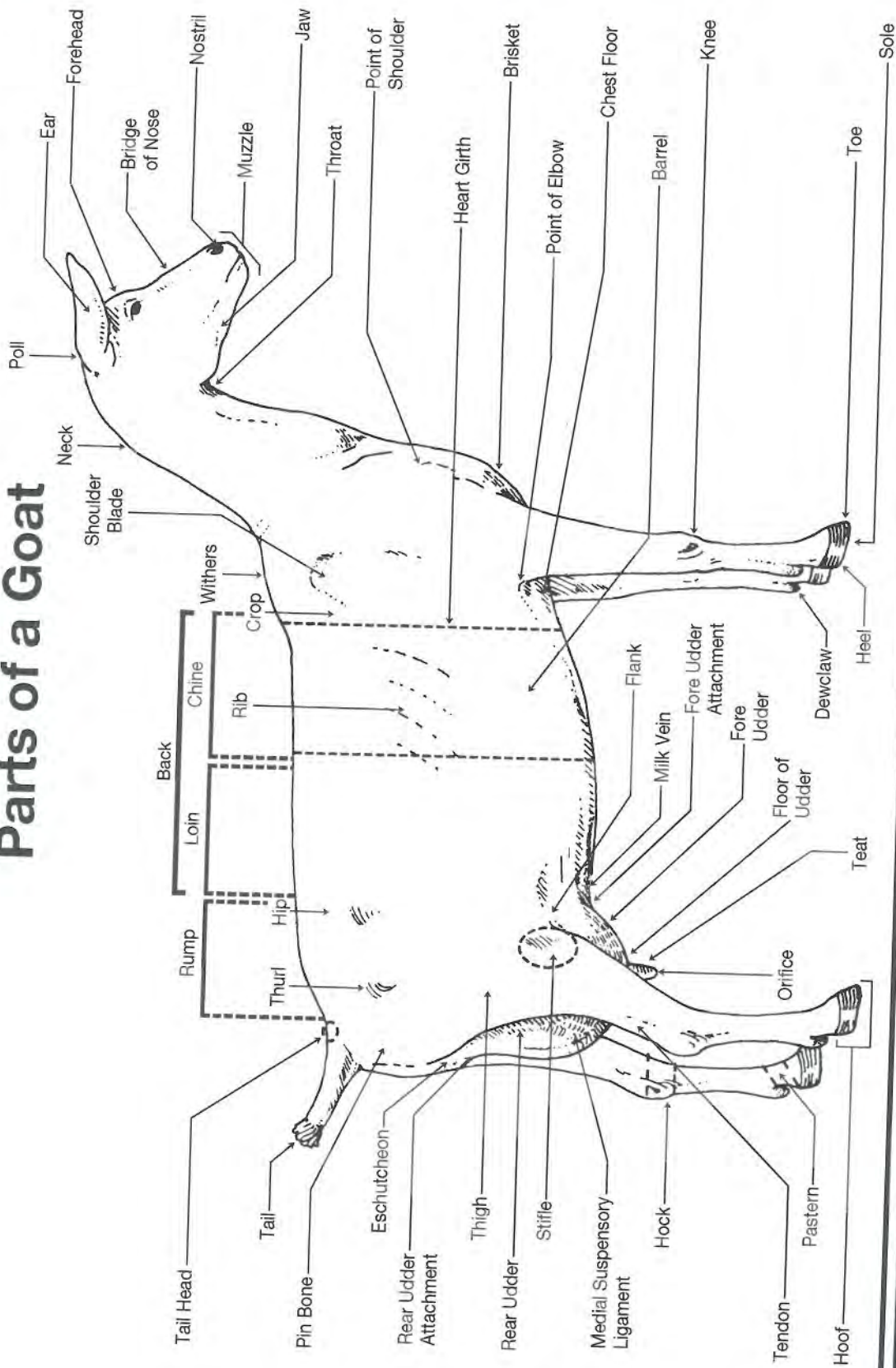


Courtesy of Dail Gracy.

The Boer goat originated in South Africa and is thought to have originated from native African goats crossed with European goats that were brought by Dutch immigrants. The name "Boer" is a Dutch



Parts of a Goat



GOAT LEARNING LABORATORY KIT

Exploratory Learning: Educational Program
 This component adapted from materials of the American Dairy Goat Association

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Table 2.1. Sample unified scorecard for dairy goats.

Points		Senior Doe	Junior Doe	Buck
A.	General Appearance An attractive framework with femininity (masculinity in bucks), strength, upstandingness, length, and smoothness of blending throughout that create an impressive style and graceful walk.	35	55	55
	Stature —slightly taller at withers than at hips with long bone pattern throughout.	2	2	2
	Head and Breed Characteristics —clean-cut and balanced in length, width, and depth; broad muzzle with full nostrils; well-sculpted, alert eyes; strong jaw with angular lean junction to throat; appropriate size, color, ears, and nose to meet breed standard.	5	10	8
	Front End Assembly —prominent withers arched to point of shoulder with shoulder blade, point of shoulder, and point of elbow set tightly and smoothly against the chest wall both while at rest and in motion; deep and wide into chest floor with moderate strength of brisket.	5	8	10
	Back —strong and straight with well-defined vertebrae throughout and slightly uphill to withers; level chine with full crops into a straight, wide loin; wide hips smoothly set and level with back; strong rump which is uniformly wide and nearly level from hips to pinbones and thurl to thurl; thurls set two-thirds of the distance from hips to pinbones; well defined and wide pinbones set slightly lower than the hips; tailhead slightly above and smoothly set between pinbones; tail symmetrical to body and free from coarseness; vulva normal in size and shape in females (normal sheath and testes in males).	8	12	10
	Legs, Pasterns, and Feet —bone flat and strong throughout leading to smooth, free motion; front legs with clean knees, straight, wide apart and squarely placed; rear legs wide apart and straight from the rear and well angulated in side profile through the stifle to cleanly molded hocks, nearly perpendicular from hock to B, yet flexible pastern of medium length; strong feet with tight toes, pointed directly forward; deep heels with sole nearly uniform in depth from toe to heel.	15	23	25
B.	Dairy Character Angularity and general openness with strong yet refined and clean bone structure, showing freedom from coarseness and with evidence of milking ability giving due regard to stage of lactation (of breeding season in bucks). Neck —long, lean, and blending smoothly into the shoulders; clean-cut throat and brisket. Withers —prominent and wedge-shaped with the dorsal process arising slightly above the shoulder blades. Ribs —flat, flinty, wide apart, and long; lower rear ribs should angle to flank. Flank —deep, yet arched and free of excess tissue. Thighs —in side profile, moderately in-curving from pinbone to stifle; from the rear, clean and wide apart, highly arched and out-curving into the escutcheon to provide ample room for the udder and its attachment. Skin —thin, loose, and pliable with soft, lustrous hair.	20	30	30
C.	Body Capacity Relatively large in proportion in size, age, and period of lactation of animal (of breeding season for bucks), providing ample capacity, strength, and vigor.	10	15	15
	Chest —deep and wide, yet clean-cut, with well sprung foreribs, full in crops and at point of elbow.	4	7	7
	Barrel —strongly supported, long, deep, and wide; depth and spring of rib tending to increase into a deep yet refined flank	6	8	8



Table 2.1 (continued).

Points		Senior Doe	Junior Doe	Buck
D.	Mammary System Strongly attached, elastic, well-balanced with adequate capacity, quality, ease of milking, and indicating heavy milk production over a long period of usefulness.	35		
	Udder Support —strong medial suspensory ligament that clearly defines the udder halves, contributes to desirable shape and capacity, and holds the entire udder snugly to the body and well above the hocks. Fore, rear, and lateral attachments must be strong and smooth.	13		
	Fore Udder —wide and full to the side and extending moderately forward without excess nonlactating tissue and indicating capacity, desirable shape, and productivity.	5		
	Rear Udder —capacious, high, wide, and arched into the escutcheon; uniformity wide and deep to the floor; moderately curved in side profile without protruding beyond the vulva.	7		
	Balanced, Symmetry, and Quality —in side profile, one-third of the capacity visible in front of the leg, one-third under the leg, and one-third behind the leg; well-rounded with soft, pliable, and elastic texture that is well collapsed after milking, free of scar tissue, with halves evenly balanced.	6		
	Teats —uniform size and of medium length and diameter in proportion to capacity of udder, cylindrical in shape, pointed nearly straight down or slightly forward, and situated two-thirds of the distance from the medial suspensory ligament on the floor of each udder-half to the side, indicating ease of milking.	4		
	Totals	100	100	100

Source: American Dairy Goat Association, <http://adga.org/scorecard.htm>

Table 2.2. Angora goat scorecard.

Traits	Points	Disqualifying Traits
BODY	50	
Size and weight for age • Yearling buck minimum 80 pounds • Yearling doe minimum 60 pounds	11	
Constitution and vigor • Width and depth of chest • Fullness of heartgirth • Spring of ribs	11	
Conformation • Width and depth of body • Straightness of back • Width of loin • Strength of back	12	Deformed mouth or feet; divided scrotum or abnormalities of testicles; sway back
Amount of bone • Size of bone below knee and hock • Clean and in proportion to size of animal • Strength of feet and legs	8	Broken down pasterns; crooked legs, including cow hocks



Dairy Goats

Dairy goats are a common project for 4-H youth because they are easy to handle and require minimal space. They also provide milk that can be consumed by the family, possibly sold (limited market potential), or used to make other products such as cheese. However, the milking procedure requires more time and daily commitment than the care and management of other types of goats. Some dairy goat breeds produce more milk, others produce milk with higher concentrations of fat and protein, and others are desirable because of their smaller size. You should select a dairy goat based on your preferences and project goals.

This chapter describes the anatomy and health of the mammary gland, composition of milk, and the procedures and equipment used for harvesting the milk from goats.

The Mammary Gland

Mammals are warm-blooded animals that give birth to live young and produce milk in mammary glands to feed their young. Goats are mammals and have a mammary gland or udder. The goat's udder has two sections or halves, each being a separate gland. The definition of a gland is "a cell, group of cells, or organ of endothelial origin that selectively removes material from the blood, concentrates or alters them, and secretes them for further use in the body or elimination from the body."

The mammary gland is very unique and has several roles:

1. It has the ability to remove nutrients from the bloodstream that originate from digestion and absorption from feedstuffs.
2. It can process and synthesize nutrients obtained from the bloodstream into milk components and secrete them into a gland.
3. It has the ability to secrete or remove milk from the gland.

The goat's udder has two separate halves, with separate glands in each half. The udder is attached to the body by a very strong support system. The main support, which also divides the udder into halves, is the medial suspensory ligament. This elastic ligament stretches and allows the udder to fill with milk. The other supporting structures are the lateral suspensory ligaments, which are fibrous connective tissue that supports the sides of the udder and comes down the sides of the udder to join with the medial suspensory ligament.

These ligaments help keep the udder closely attached to the body. If these support structures start to break down or are not very tight initially, the udder will be pendulous. Pendulous udders are easily injured because they are closer to the ground and also because they swing easily, sometimes hitting hard surfaces. Pendulous udders also cause problems with milking. These factors can decrease the length of time the animal spends in the herd.

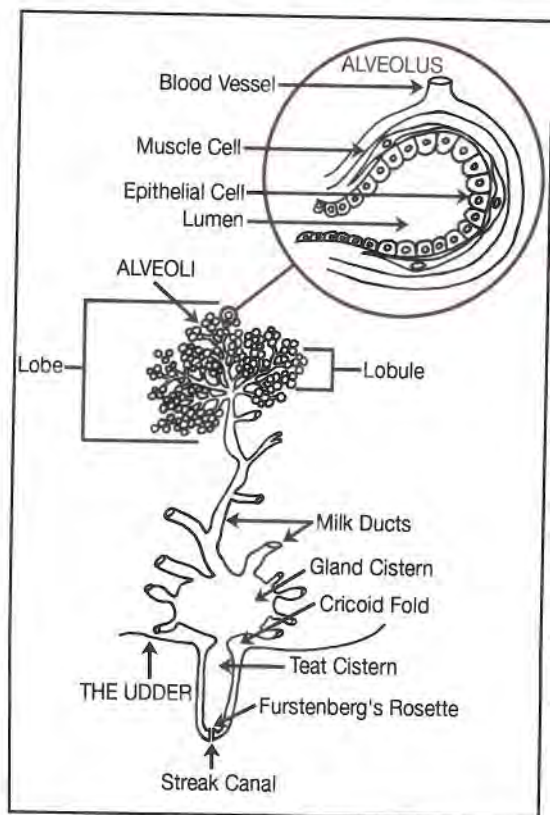
Illustrations of goat mammary structure are on the following pages.



Anatomy of the Mammary Gland

Let's start with the smallest unit in the udder and look at the pathway milk follows as it moves out (see figure 7.1). The smallest unit in the udder is called an alveolus (plural is alveoli). This is where the milk is actually made. Surrounding each alveolus are myoepithelial cells, or muscle cells, and very small blood vessels called capillaries. The alveoli are in groups, like grapes. These groups form alveolar lobes. The lobes empty into small milk ducts, which empty into large milk ducts. The large milk ducts empty into the gland cistern. A majority of the milk is stored and held in the gland cistern. This is different from cattle, because cattle store most of their milk in the alveoli with very little storage in the gland cistern.

The teat cistern is the next area; milk empties out of the teat cistern through the



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Figure 7.1. Anatomy of the mammary gland.

streak canal. The streak canal or teat canal is lined with a sticky, waxy substance called keratin. Keratin helps keep bacteria out of the mammary gland and prevent mastitis. Circular muscles called the sphincter muscles surround the streak canal. Sphincter muscles can be loose or tight, affecting how fast the milk is released. Does that milk out easily or that start to leak before you get to milk them may have loose sphincter muscles. Hard-milking does may have tight sphincter muscles.

Milk Synthesis and Letdown

Blood comes into the udder where the udder meets the body wall. Blood leaves the udder through the milk vein. The milk vein is the large blood vessel that runs along the abdomen of the animal. Approximately 300 to 500 pounds of blood pass through the udder for each pound of milk produced. The alveolus is made up of a single layer of epithelial or milk-producing cells that make a small pouch. The inside of the alveolus is a hollow area or lumen. Milk-producing cells pull nutrients from the blood and synthesize the milk components, such as casein, lactose, milk fat, vitamins, and minerals. The milk components are secreted into the lumen of the alveolus. When the alveoli are full, milk is secreted into the milk ducts and into the gland cistern, the main storage area of milk.

Female goats, as with all mammals, start lactating after giving birth to their young. To get the most milk out of your does, they need to be healthy, comfortable, in familiar surroundings, and familiar with the individuals doing the milking. Several hormones are involved with mammary development and milk production. The most important hormone in the milking process is oxytocin (see figure 7.2). Oxytocin is



responsible for milk letdown and is stored in the posterior pituitary gland at the base of the brain. Udder preparation for milking stimulates oxytocin release, similar to the kid nuzzling the udder to nurse. Oxytocin travels from the brain through the bloodstream to the udder, where it causes the myoepithelial cells surrounding the alveoli to contract and squeeze milk from the alveoli. The milk ducts fill with milk and mammary pressure increases, making the doe easier to milk. Other familiar repetitive actions can also stimulate milk letdown, such as seeing the milker, entering the milk room or parlor, or hearing and seeing other animals being milked.

Once oxytocin is stimulated, it takes 20 to 60 seconds for the full milk letdown

response. This response lasts only 5 to 6 minutes because the liver and kidneys do a very good job of removing oxytocin from the bloodstream. This is why it is extremely important to milk does quickly once the milking process has started.

A hormone that works opposite of oxytocin is epinephrine (also called adrenaline). Epinephrine is the “fight or flight” hormone. It is released when the goat is scared, startled, or disturbed in some way. It acts opposite of oxytocin in that it causes constriction of the capillaries and blood vessels and inhibits the myoepithelial cells from contracting. Does that are in new places, have new milkers, or are upset and stressed do not produce as much because epinephrine prevents proper milk letdown.

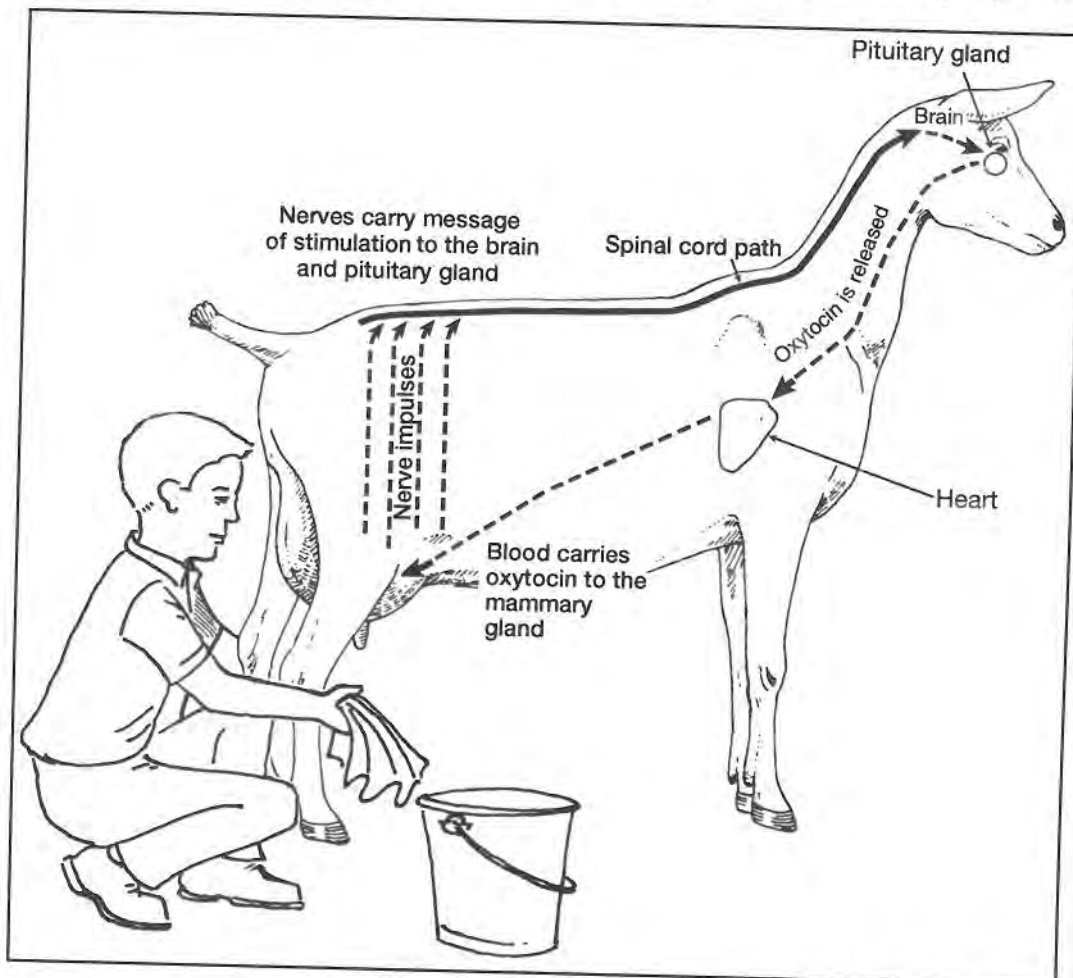


Figure 7.2. Pathway of oxytocin release in milk letdown.

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Mammary Health and Mastitis

The goat's mammary gland can be susceptible to mastitis. **Mastitis** is an infection or inflammation of the mammary gland and is caused by pathogens, like bacteria. Bacteria usually enter the udder through the streak canal and cause an infection. Occasionally, mastitis can be caused by a systemic infection in the animal, but it is not common. Infection can be spread from animal to animal during the milking process. When bacteria enter the mammary gland, the immune system releases white blood cells, or somatic cells, to fight off infection. Somatic cells destroy bacteria and are helpful in repairing damage to glandular tissue. Somatic cells are always present, even in normal milk, but concentrations greatly increase during mastitis.

Goats produce milk differently than does do. When milk is produced in the udder, more somatic cells and other cellular material are shed into the milk than with cattle. This leads to goats having naturally occurring higher somatic cells counts (SCC) than cattle, while not necessarily having an intramammary infection. Currently, the legal limit on Grade A goat milk is 1 million cells/ml of milk, compared to 750,000 cells/ml of milk for does. Somatic cell counts also vary due to stage of lactation. They are higher at the beginning and the end of lactation, so this variation must be taken into account when managing the goat herd.

Mastitis can cause a considerable amount of economic loss to a dairy goat producer. Much of the loss is due to decreased milk production potential, discarded milk, lost production, drug and veterinary costs, increased labor costs, and increased replacement cost for the animal if culled.

Milk quality also affects processing of milk products. Decreased cheese production, decreased shelf life of a product, and less acceptance by the consumer of the product are all consequences of poor milk quality. Although not many 4-H projects are milking animals for commercial use, mastitic milk still can have a negative effect. Milk with high SCC should not be used for human consumption and should be pasteurized if fed to kids.

Prevention of mastitis can be as simple as having does kid in clean dry areas, having the housing areas clean and dry, and using proper milking procedures.

Types of Mastitis

The two types of mastitis are clinical and subclinical.

Clinical mastitis is characterized as mastitis showing visible signs of infection. Visible signs include abnormal milk, hot udder, hard spots in the udder, fever, swelling, and sensitivity to the udder. There are two types of clinical mastitis—acute and chronic. Acute mastitis occurs when animals exhibit all the signs of mastitis. Chronic mastitis is when the infection remains at low levels, but flares up with mild or severe occurrences. Clinical mastitis is observed in less than 5 percent of animals in a well-managed herd.

Subclinical mastitis occurs when there are no visible signs of mastitis or infection, but when somatic cell counts are above normal. As mentioned earlier, somatic cells fight infections. An above-normal somatic cell count indicates the animal is fighting an infection. Up to and above 50 percent of animals in a herd can have subclinical mastitis at any given time.



Mastitis Testing

Several tests can be used to detect subclinical mastitis. These tests were originally developed for goats and are good management tools to use in the goat herd even though goats have a naturally higher milk SCC. Milk SCC in goats is not necessarily a reliable indicator of a mastitis infection, as normal SCC per milliliter of milk in a healthy goat can vary between 50,000 and more than 1 million cells/ml. If SCC exceeds 1 million cells/ml, further testing is needed to determine if the high numbers are due to mastitis or biological variation in the doe.

The Dairy Herd Improvement Association (DHIA) has a milk-testing program and can monitor SCC for animals on test. The electronic somatic cell count program uses an electronic counting device to count the number of somatic cells. A report is sent to the producer with the doe's SCC.

On the farm, producers can use the California Mastitis Test (CMT), shown in figure 7.3. This test was originally developed for cattle but can also be used in goats. By mixing a sample of milk and the CMT reagent, a score of 0 to 5 is assigned. Scores of 1 or higher indicate the milk contains more than 1 million cells/ml.



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Figure 7.3. California Mastitis Test (CMT).

The Wisconsin Mastitis Test is much like the CMT, but it is performed on the bulk milk samples instead of on individual doe samples. Milk processors usually do this test before accepting a bulk tank of milk from a producer. This test takes more time than the CMT but is more objective.

The official SCC test for goat's milk is the Direct Microscopic Somatic Cell Count (DMSCC), which uses Pyronia Y-Methyl Green stain. This process stains the somatic cell nucleus and the cells are then counted under a microscope. Only white blood cells (leukocytes) have a nucleus. If the increase in cell count is due to leukocytes in the milk, then there may be an intramammary infection. Currently, there is no method to distinguish whether high SCC milk from goats is caused by mastitis or by some other physiological cause. This is why the high legal limit of 1 million cells/ml of milk remains. If any of the above tests have over 1 million cells/ml of milk, the DMSCC test is done for verification.

Organisms that Cause Mastitis

Mastitis in dairy goats is most commonly caused by Staphylococci species, such as *Staphylococcus epidermitis* and *Staphylococcus aureus*. *Staph. epidermitis* is commonly found on the skin of human hands and on the udders of goats. *Staph. aureus* is the most common bacteria isolated from mastitis cases in dairy goats. A very small percentage of mastitis is caused by other organisms, such as the Streptococci species, including *Streptococcus uberis*, *Streptococcus dysgalactiae*, and *Streptococcus agalactiae*. While Mycoplasma is troublesome in some dairy doe herds, it is rare in dairy goat operations and is most commonly associated with pneumonia.



Teat Disinfection

The use of teat dips is recommended by the National Mastitis Council to decrease the incidence of mastitis. Teat dipping does not totally prevent the incidence of mastitis, but it certainly helps.

Pre-dipping of the teats before milking is recommended if the udder is fairly clean. Pre-dip is applied, left on for 30 seconds and then wiped off with paper towels. Do not share towels between animals, as this passes mastitis-causing organisms between animals.

After milking, a post-milk teat dip should be used. Approximately one-half to two-thirds of the teat needs to be dipped, and the dip is left on. Give the goats feed after milking to keep them on their feet for at least 30 minutes, because it takes approximately that long for the teat ends to close up after milking. If animals lie down before the 30 minutes is up, then the teat ends can be contaminated. If the temperature is 10°F or below, blot the teat dip to remove any droplets and prevent frost damage to the teat. Teat disinfection does not cure or affect current cases of mastitis. Treatment is necessary for current cases.

Caring for the Mammary Gland

Taking good care of the mammary gland of your animal is crucial whether you are milking your dairy animal or feeding your kids on a doe. Examine the udder prior to freshening to make sure there are no cuts, scrapes, bruises, or signs of infection that could affect the milking or feeding process. Keep the area free of hardware, such as nails, boards, or screws, that could cause damage to the udder. It is helpful to trim the hair from the udder before kidding. This lessens the amount of dirt and bacteria that can enter the mammary gland.

Mastitis is a disease that not only affects the dairy operation but also the meat goat operation. Does that have mastitis have decreased milk production and may not let kids nurse because of a painful udder, resulting in decreased growth rates and possible loss of the kids.

Milking Procedures

Whether animals are being hand milked or machine milked, there is not much difference in milking procedures. The purpose of milking is to harvest milk. Milk and milk products are one of the most nutritious foods available because they provide vitamins, minerals, and protein. To further promote the growing dairy goat industry, you need to produce a wholesome, good tasting product and to be aware of what the consumer would think of your farm and milking procedures.

Providing proper milking procedures, good management, and clean facilities ensures that high-quality milk is produced for the consumers of the milk and milk products. They also provide the doe with a familiar milking routine for maximum milk production.

Pre-Milking Procedures

The milking equipment and the milker's hands should be clean and dry before milking occurs to minimize bacterial contact and reduce the chance of mastitis. Physically examine the udder and teats for any signs of injury, frostbite, chafing, or if a half is hard, hot, or sensitive to the touch. Also, strip a few streams of milk from each teat (fore-strip) to check for abnormal milk. Abnormal milk is any milk that is "stringy, pink-tinged, clumpy, flaky, or watery." Strip from each half into a strip cup or onto the



milking parlor floor. These first few streams of milk are usually high in bacteria and somatic cells and help to flush out the teat canal. Do not fore-strip into your hands because this may spread mastitis-causing organisms to another doe. Fore-stripping also helps with the oxytocin release and milk letdown.

After examining for signs of mastitis or injury, and fore-stripping, the next step is to disinfect and stimulate the teats. A sanitizer or an approved pre-dip should be applied to the teats. The pre-dip should remain on the teats for at least 30 seconds to be effective. When pre-dipping, use a clean dip cup with fresh pre-dip. Teats should be fairly clean before teat disinfection. If washing is practiced, use individual towels for each doe. It is then very important to dry the teats thoroughly using either paper towels or cloth towels. Not drying thoroughly can leave mastitis-causing organisms on the teats, and hand milking wet teats can cause mastitis-causing organisms to go back into the gland through the teat canal. If machine milking, wet teats increase the chances of slips and squawks, which increases the chance of mastitis. To dry the teats, use only **one** towel per doe and **never** share towels between does. Cloths used on more than one doe can transfer mastitis-causing organisms to other does. If cloth towels are used, launder them in hot water with soap and bleach between uses.

Milking

The milking process should be started within 1 minute of starting the pre-milking procedures to take advantage of milk letdown.

If hand milking, milk with clean, dry hands into a stainless steel hooded bucket. Before milking the next doe, wash and dry hands

thoroughly. Be gentle while milking and avoid rough, vigorous milking, as teat damage may occur.

If machine milking, attach the unit carefully to not let air enter into the system. Most goats milk out in 2 to 6 minutes. Avoid stripping with the machine (pulling down on the claw or a teat cup to remove the last small amount of milk in the udder) as this can increase liner slips and the chance of the doe getting mastitis.

Remove the milking unit as soon as the last half is milked out. Many modern milking units are equipped with automatic take-offs; these should be checked to make sure that they are adjusted correctly. If the parlor does not have automatic take-offs, the vacuum should be shut off at the claw, and then the teat cups removed. Removing the teat cups while the vacuum is still on can cause liner slips, possible new infections, and harm the teat end.

Post-Milking Procedures

Teats should be dipped with an approved germicidal post-milking teat disinfectant immediately after milking. Teat dip cups should be cleaned routinely and fresh disinfectant should be used for each milking. If using teat sprayers or a spray bottle, be sure to cover all sides of the teat. A common mistake with spraying teats is spraying only one side. The goal is to cover the entire bottom one-half to two-thirds of the teat with disinfectant. Dipping is preferred over spraying because of better teat coverage. Also, less dip is used when dipping. Teats can continue to be disinfected in cold weather; however, if it is below 10°F or the wind chill is very low, remove excess teat dip after 30 seconds to prevent frostbite and chapping.



A good teat disinfectant kills mastitis-causing organisms on the teat and prevent bacteria from getting into the teat canal. Many commercial teat disinfectants have been shown to reduce the rate of new infections by approximately 50 percent. If mixing disinfectants from concentrates, follow these guidelines: (1) mix small batches more often, (2) never mix old disinfectant with newly mixed disinfectant, and (3) use only clean, potable water to mix. Check with the manufacturer to be sure that your water meets the correct pH and hardness standards as these can alter effectiveness. Contact your local Extension office or veterinarian if you would like to obtain research results on teat disinfectant effectiveness.

Hair Removal

It is recommended that hair be removed from the doe's udder and flanks to reduce the amount of dirt and bacteria near the teat. This makes udder preparation easier and reduces the risk of milk contamination. Hair is most easily removed by clipping. Hair should be removed about every 3 months, maybe more often in cold weather.

Milking Facilities

Milk is a highly perishable food product. Care must be taken when handling milk to preserve quality. Several management techniques have a large impact on milk quality. Improper feeding, poor handling of animals, and improper milk handling before and after milking all negatively impact milk quality.

Many people say that they do not like goat milk because it tastes "goaty," with a flavor very different from doe milk. If handled properly, goat milk should not have a "goaty" flavor. Compared to doe milk, goat

milk is higher in the medium chain fatty acids, which include caproic, caprylic, and capric acids. These fatty acids are enclosed in the milk fat globule, which is more fragile than the fat globule of doe milk and is easily broken during handling and cooling. Insufficient cooling of the milk causes the milk fat globule to break, resulting in a "goaty" flavor and a less desirable product.

The milking facility is one of the main areas to control milk quality. On most farms, the kitchen serves as the main area for processing milk. On larger dairy farms, the size and extent of facilities depend on the number of animals being milked and on the goals of the producer. Milk processing is discussed in Chapter 13.

Regardless of the size of the dairy or number of animals, the milk room should be separate from the animal housing area and should have a solid floor, such as concrete or tile, with a drain for easy cleaning.

If possible, facilities should have hot and cold running water along with separate sinks for washing equipment and another for washing hands between animals. If you want to set up a Grade A or manufacturing-grade dairy farm for selling milk and milk products, such as cheese and/or yogurt, the dairy needs to meet certain guidelines in the Pasteurized Milk Ordinance and to pass inspection by the state. State milk inspectors can also help with the planning and set-up of a Grade A or manufacturing-grade milking facility. In Ohio, contact the Ohio Department of Agriculture, Dairy Division.

Hand-Milking Facilities

A basic facility with individuals who milk a small number of goats is a milk room with a milking stand and no running water. Care must be made to properly disinfect and



clean the udder before milking, and milk should be milked into a seamless, stainless steel hooded bucket. This type of bucket allows less odors to be absorbed by the milk and minimizes bacterial contamination. Plastic buckets tend to get pitted and grooved and can hold bacteria, even after disinfecting. After milking, post-milk teat dipping is recommended. See Chapter 13 on processing of milk after milking.

Automated Milking Facilities

Automated milking of goats occurs one of two ways: (1) bucket milking or (2) a pipeline system.

Bucket Milking

A bucket-milking unit has a bucket, pulsator, and claw and is hooked up to a vacuum system. You can have buckets that milk just one animal, or buckets that milk two animals at once. Milk travels from the udder into a bucket and is then usually carried to a cooling and storage system before further processing.

Pipeline System

In a pipeline system, milk is transported directly from the udder to a refrigerated bulk tank for cooling and storage. A pipeline system commonly uses one of three types of parlors—parallel, herringbone, or rotary. There are advantages and disadvantages of each system, depending mainly on how many does are to be milked and on operator preference.

In the parallel parlor, the does are situated next to each other at a 90-degree angle to the milker and are milked between the back legs (see figure 7.4). The big advantage of parallel parlors over herringbone parlors is less space between each doe. This reduces prep time and travel time between does.

The size of the milking center building can also be reduced because the parallel parlors take up less space.



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Figure 7.4. Parallel milking parlor.

In the herringbone parlor, the does are stationed at an angle to the milk alley and are milked from the side (see figure 7.5). An advantage of the herringbone over the parallel is cleanliness; when a doe urinates or defecates, it does not occur on the milker or by the milking unit.



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Figure 7.5. Herringbone milking parlor.

Does in a rotary parlor are set up on a platform with the stalls in a circle, with



their heads facing the center (see figure 7.6). The number of stalls or units depends on the number of animals being milked. The parlor rotates while the milker stays in position. The rotary parlor is advantageous when milking a very large herd. Rotary parlors are typically more expensive than herringbone or parallel parlors.



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Figure 7.6. Rotary milking parlor.

Milking Equipment and Maintenance

The main goal of milking is to produce a safe, high-quality product. Milk needs to be free of pathogenic bacteria, high somatic cell counts, antibiotics, insecticides, and herbicides. It also needs to taste good. Many dairy goat owners milk their goats by hand. Even so, producing high-quality milk and other products for consumer use is possible. Proper milking equipment and care of that equipment is necessary.

To be a Grade A (fluid milk) or manufacturing-grade dairy farm requires a license and inspection by the state dairy inspector. Proper milking and milk handling procedures are regulated by the state. If you want to sell milk or milk food products, contact the Dairy Regulation Department in your state. Goat dairy farms must follow

the same rules as dairy doe farms for producing and selling milk and milk products.

Hand Milking

For home use, the only equipment that is necessary is a milking stand, a seamless, stainless steel hooded pail, and a clean milking area. Do not use plastic equipment, as it is porous and is very hard to sterilize and keep free of bacteria. A metal milking stand is more sanitary than a stand made of wood because metal is easier to disinfect.

Automated Milking

When milking with a machine, the equipment needs to function correctly or milk quality decreases. Improper milking equipment can cause teat or udder injury, increase cases of mastitis, or decrease milk production by leaving milk in the udder. (These same problems can occur with hand milking if proper milking procedures are not followed.)

A milking machine (see figure 7.7) mimics how a kid nurses on the teat; milk is sucked out, not squeezed out as in hand milking. There are three basic functions of the milking equipment: (1) to create a controlled vacuum or low air pressure at the teat end to open the teat orifice and to allow milk to flow efficiently, (2) to massage the teat intermittently to provide stimulation and minimize blood and lymph congestion at the teat end, and (3) to move and handle the milk in a way conducive to maximizing milk quality, quantity, and flavor.

The four essential parts of the automated milking system are (1) the vacuum supply system, (2) the pulsation system, (3) the milk line system, and (4) the milking unit. The vacuum supply system consists of the vacuum pump and the regulator. It creates a vacuum that moves and regulates air





Courtesy of Hoegger Supply Company.

Figure 7.7. Milking machine.

through the system. Air must be removed from the system to create low air pressure or a vacuum. Vacuum pressure must be regulated (by letting atmospheric air in) to provide a controlled, stable vacuum or consistent low pressure at the teat end. This allows the teat end to open and milk to flow from a high-pressure area (the udder) to a low-pressure area (the milking unit). To maximize milk flow, there needs to be a large pressure difference between the doe and the machine. However, the pressure cannot be too high, or the doe's teats will be injured and mastitis can result. Always set vacuum levels according to the requirements of your milking system, as these are different for bucket systems versus milk line systems.

Vacuum Pump

The vacuum pump is a mechanical device that extracts and exhausts air from the system to create a vacuum. Pumps are rated by the amount of air they can move, measured in cubic feet per minute (CFM). The amount of CFM needed in a system depends on the number of milking units. A series of pipes or lines are needed to distribute the vacuum to the milking and pulsation systems. Vacuum lines should be

properly sized according to the amount of air or CFM being moved through them. The vacuum pump should be located in a clean, dry room near the milking center. If it is located too far away, a larger pump than necessary may be needed. The room should be large enough to do any maintenance necessary. The pump should not be kept very close to the milking parlor because of the loud noise and because of the risk of contamination of milk from the oil in the pump. The vacuum pump should have a vacuum gauge and a test port on the main line. The vacuum gauge should be checked during milking to make sure a stable vacuum is occurring. If fluctuations are noted, the test port can be used to check the vacuum pump and make sure it is working correctly. There should be a cut-off valve after the test port so that pressure can be accurately measured at the port. This measures airflow from the pump, not exhaust. It is crucial to test the vacuum during milking with all units on to evaluate the system correctly. If bucket milking, the vacuum pump may be portable. For proper vacuum, use a bucket milker that is made for goats, not cattle.

Regulator

Vacuum pump regulators maintain a stable vacuum pressure in the line. Sensors control valves that allow air to enter when necessary so the system does not exceed the set limit for vacuum. The regulator senses all air going in and out of the system and continually adjusts for the difference. It is extremely important to have a sensitive regulator and to install it in the proper place. Because regulators are a very important part of the milking system equipment, they must be routinely cleaned and checked for proper functioning.



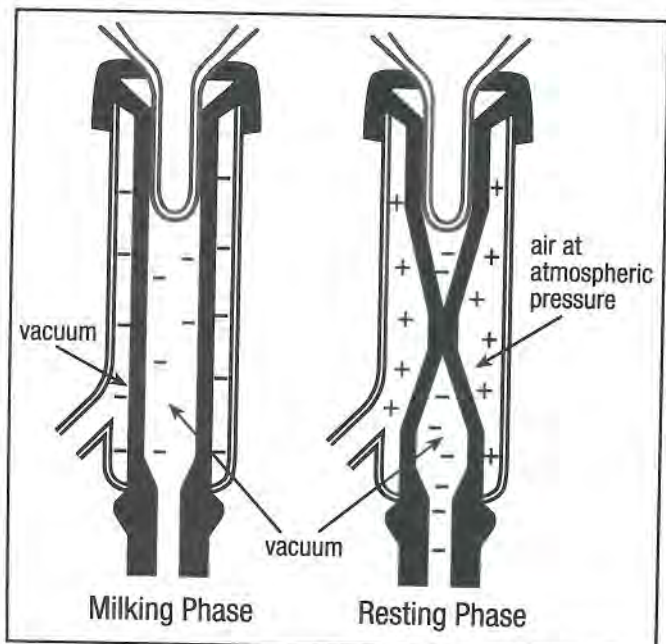
Pulsator

The pulsator is an automatic air-vacuum valve that directs atmospheric air into the hoses and chamber between the teat cup liner or inflation and the shell. This alternates the vacuum and atmospheric air between the shell and the liner and is responsible for the actual milking action. The pulsator removes the air by opening a port into the vacuum system, causing the liner to inflate and be in the milk or open phase. When the pulsator lets air in between the shell and the liner, the liner collapses and massages or rests the teat.

Pulsators have many small working parts and should be cleaned and maintained regularly. They should be evaluated and checked by a certified equipment service person with the proper equipment. Air hoses should be checked regularly for cracks and splits and should be changed once a year.

Pulsation Rate and Ratio

Pulsation rate is the number of times that the teat goes through the rest and milk phase (see figure 7.8). The two phases make



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up one cycle. This is how fast the doe is going to be milked. You do not want this to be too slow or too fast. Common rates are 60 to 90 cycles per minute. A lower number of cycles per minute results in a slower milking speed.

Pulsation ratio describes the proportion of the cycle that is in the rest phase versus the milk phase. Generally, pulsation ratios are 50:50 or 60:40. For example, if the pulsation ratio is 60:40, this means that 60 percent of the cycle is in the milking phase (liner open) and 40 percent of the cycle is in the rest phase (liner closed).

Milking Unit

The milking unit is the part of the machine that is suspended from the doe, performs the milking operation, and receives the milk. It includes the teat cup assembly (shell and inflations or liners), claw, and connecting milk hoses. Components should be sized to maximize milk flow from the teat. Hoses should be as short and straight as possible to minimize air and milk flow restrictions. Inflations are the only piece of the milking unit to touch the doe. The inflations change shape during every pulsation. It is very important to replace inflations at the recommended time. Not doing so increases the risk of mastitis due to poor milk-out and increased liner slips or squawks that allow an unexpected rush of air in the system. There is also an increased chance for bacteria to harbor in the cracks.

Air bleed holes in the inflations or claw (there should be only one, either in the claw or in the inflation) allow a precise quantity of air in to increase air pressure (lower vacuum) slightly so that milk can be moved efficiently. Routine listening to air bleed in this hole at milking, as well as other air admission places, is important. Keep bleed



holes open or milk flow will slow down, causing a large vacuum drop. Do not make the holes too big, as excess air causes milk agitation, slowed milk-out, and increased risk of mastitis.

Cleaning and Sanitizing

Keeping your milk system clean is one of the most important tasks on the farm. Dirty milk lines cause an increase in milk bacterial counts and reduce milk quality.

Two types of cleaning systems are normally used on the farm. One is a manual system, where the milk-line system or milk buckets are cleaned by hand. The other is a Clean in Place (CIP) system, which is automated. Whichever way you clean your system, it should be done immediately after milking to prevent the build-up of milk solids in the lines and on the buckets. You should always follow cleaning recommendations and directions from the milking equipment manufacturers.

Proper and routine maintenance is essential to keep milking systems functioning properly. Pulsators, bleed holes, and regulators (air inlets) should be cleaned routinely when inflations are changed or at least every six months. Inflations or liners should be changed routinely according to the material and brand used. All hoses should be replaced annually and a certified service person or veterinarian should evaluate the milking system at least once a year to evaluate pump, regulator, and vacuum system performance, pulsators, and milking time performance. Milk lines should be cleaned daily. The buckets, cans, or bulk tanks should be cleaned each time they are emptied, and vacuum lines should be cleaned at least twice a year.

For specific information on automated goat milking systems, see “Guidelines for the

design, installation, and cleaning of small ruminant milking systems,” Dairy Practices Council #70 (www.dairypc.org).

Modifying equipment made for goats can be done but is not always the best option as small ruminants have needs for different pulsation rates and vacuum levels. Contact your local equipment dealer and see what your options are for setting up a system that will work best for you.

Dairy Goat Products

Although cow milk is the major fluid dairy product consumed in the United States, goat milk is more highly consumed in the rest of the world. In many developing countries, goat milk is cheaper to produce than cow milk, and goat milk production is possible in places where the landscape and terrain prohibit the grazing of larger animals. Cost of production, land availability, and efficiency are not the only reasons people choose goat milk production. The composition of goat milk also may make it more digestible.

Composition of Milk

Goat milk has a similar composition as cow milk. The average composition of milk from goats, cows, and humans is provided in table 7.1. Notice the similarities between the composition of milk from goats and cows (American Dairy Goat Association; <http://www.adga.org>). Despite having similar compositions, goat milk and cow milk are still very different. The fat in goat milk contains more shorter-chained fatty acids than cow milk, and the fat globules are smaller than the globules in cow milk. Goat milk is sometimes called “naturally homogenized” because the fat



does not separate as it does in cow milk. Fat globules separate in cow milk because they are larger and because of a protein that causes them to group together and separate from the liquid. These proteins, called agglutinating euglobulins, are not present in goat milk, giving the appearance of natural homogenization.

Table 7.1. Comparison of the composition of goat, cow, and human milk.

	Goat	Cow	Human
Protein, %	3.0	3.0	1.1
Fat, %	3.8	3.6	4.0
Lactose, %	5.1	4.9	7.0
Calories/100 ml	70	69	68
Cholesterol (mg/100 ml)	12	15	20
Calcium, %	0.19	0.18	0.04
Phosphorus, %	0.27	0.23	0.06
Iron, %	0.07	0.06	0.2
Vitamin A (i.u./g fat)	39	21	32
Vitamin B1/ thiamin (µg/100 ml)	68	45	17
Riboflavin (µg/100 ml)	210	159	26
Vitamin C (mg ascorbic acid/100 ml)	2	2	3
Vitamin D (i.u./g fat)	0.7	0.7	0.3

Milk Processing

Though the composition of goat and cow milk differs slightly, the handling and processing of the milk from both species is similar, especially on large dairy goat operations. However, as we will learn later, many dairy goat producers process and

develop their own products, which changes the way the milk is handled from farm to refrigerator. Size of operation and method of milking (hand versus milking machines) definitely influence the type of processing the milk undergoes.

Because milk spoils easily, the dairy industry is highly regulated by the Federal Food and Drug Administration (FDA). Each state is responsible for enforcing the rules and processing regulations. Dairy farms and milk processing plants are routinely inspected to make sure the facilities are clean and that milk is handled properly and safely. This is to make sure that all milk and all milk products arrive safely to the consumer. Commercial dairy goat milk processors make their products under the Pasteurized Milk Ordinance (PMO). In addition to the PMO, goat milk undergoes inspection, sampling, and laboratory testing to ensure that it conforms to quality standards and that it is pure and wholesome for human consumption.

When milk is on the farm, it is kept in a large tank called the bulk tank (see figure 7.9). This is a refrigerated tank that keeps the milk cool (less than 40°F, but above freezing) and prevents bacteria from growing. Milk is picked up in a refrigerated tank truck (see figure 7.10) that carries the milk to the processing plant. Number of goats in the herd and the size of the bulk tank determine how often the milk truck comes. The milk on a truck is usually be from several different farms.

When the milk hauler picks up the milk at the farm, employees take a sample of milk from each individual bulk tank. This sample is then tested for antibiotic residues, milk fat, milk protein, bacteria, and SCC.





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Figure 7.9. Bulk tank.



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Figure 7.10. Tank truck.

Today's milk processing plants are almost fully automated. They are full of stainless steel tanks, pipes, and machines that handle the milk from the time it enters the plant to the time it is packaged for the consumer. Every day, all of the equipment is cleaned and sanitized to make sure that the milk stays safe to drink.

Look at the processes described below and in figure 7.11—a lot goes into taking milk from the farm to the grocery:

The processing of fluid milk starts with clarification, which is the removal of sediment, such as dirt, epithelial cells, leukocytes, and bacteria, by filtration and centrifugation. The milk is then pasteurized, or heated, to kill any disease-causing organisms. There are several methods of pasteurization. One is batch pasteurization, which heats up the milk to 145°F (63°C) for 30 minutes. Another is flash pasteurization, which heats the milk up to 160°F (71°C) for 15 seconds followed by a rapid cool down.

Flash pasteurization is also called high-temperature short-time pasteurization (HTST). The equipment used for this type of pasteurization is different than for batch pasteurization. Milk during HTST is run through many very small tubes to heat and route the milk to where it needs to go. The majority of modern processors use HTST for several different reasons:

1. The equipment takes up much less space than the equipment for batch pasteurization.
2. The process is a more efficient use of labor; it requires less people.
3. The equipment is easier to clean and sanitize.
4. The equipment is cheaper and can easily be expanded.

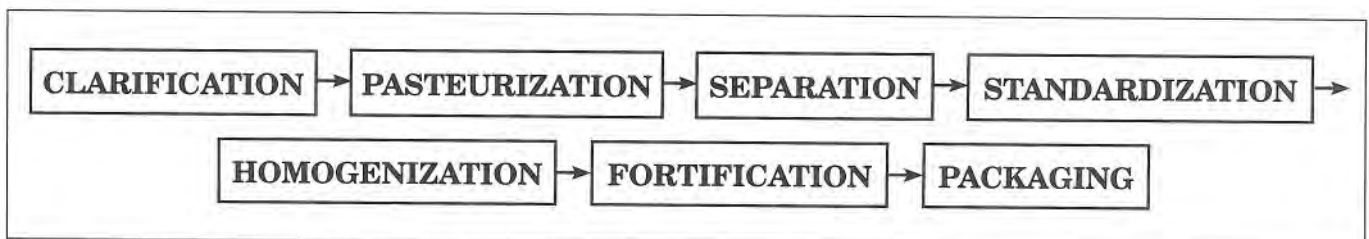


Figure 7.11. Milk production processes.



Recent technology has developed a new pasteurization process called Ultra High Temperature (UHT) pasteurization, which heats the milk up to 250°F (under pressure) for 1 to 2 seconds. The UHT process is mainly used for coffee creamers and juice. However, Europeans commonly pasteurize milk this way. The UHT products do not require refrigeration until after they have been opened because the UHT process sterilizes the milk. These products often have a slightly “cooked” flavor.

After pasteurization, the milk is immediately cooled to 40°F. For the rest of the processing, the milk is kept at this constant cool temperature. Now the fat is separated from the milk in a process called separation, with the result being cream (fat) and skim milk.

Standardization is the next step in getting the milk to your grocers’ shelves. Standardization brings all of the milk from different farms to the same milk fat percentage. Goat milk composition can vary widely from goat to goat and farm to farm, so standardization becomes very important in meeting federal and state requirements for goat milk product processing.

Milk is then homogenized. This is the process of breaking up the fat particles into smaller pieces so that they stay mixed in the milk. While goat milk is naturally homogenized, some of the pasteurization steps may cause the milk fat to separate, especially when using HTST pasteurization. Large-scale pasteurization operations often homogenize goat milk. However, smaller operations or those with batch-size processing may find homogenization unnecessary. After homogenization, milk is fortified with either vitamin A or D, or both. Finally, milk is put into plastic jugs or bags,

cartons, or boxes and delivered to grocery stores and restaurants, ready to be served. Milk that is not packaged for you to drink is made into other dairy products. Ice cream, cheese, and yogurt are just a few.

Small Scale Processors

While some fluid milk is marketed by large scale processors, other dairy goat producers prefer to process, package, and market their own dairy goat milk products. Some people have interest in raw goat milk (milk that has not been pasteurized). Remember, pasteurization kills disease-causing organisms, so drinking raw milk poses some serious health risks. Besides health risks, selling raw milk is against the law in Ohio and consumption is highly discouraged by the United States Department of Agriculture.

Many small-scale dairy goat producers own their own milk processing equipment and supplies. Pasteurizers can easily be purchased and used on the farm. Farm direct products are growing in popularity in the dairy industry, both for dairy doe and goat producers.

Cheese and Other Products

Besides fluid milk, goat milk can also be used for producing a variety of value-added products, like cheese or powdered milk. Many on-farm processors market their goat milk through value-added products. Perhaps the most popular use of goat milk is for making cheese. In the United States, goat cheese consumption has been on the rise. Actually, the United States needs to import goat cheese from other countries to meet the consumer demand. The majority of goat cheeses come from France, but Italy and Norway also produce goat cheese.



Making cheese from goat milk requires four main steps.

Step 1. Preparation of the cheese milk

Step 2. Coagulation of the milk protein (casein)

Step 3. Separating the curd from the whey

Step 4. Aging

Preparation of Milk for Cheese

In commercial cheese production, the first and most important step is standardization of the milk. As discussed earlier, standardization adjusts the milk fat and protein contents to a set level. Commercial cheese processors have to produce cheese that is of uniform quality and of legal composition. There are federal and state laws that specify fat and protein composition of dairy products. Goat producers making cheese for their own consumption probably are not concerned with the composition of their product, but if the cheese is to be sold commercially, it must meet the established standards.

Milk destined for cheese production also needs to be low in bacteria counts. Some of the later steps in cheese making use special, beneficial bacteria, so if there are a lot of undesirable bacteria in the milk itself, this interferes with steps in the cheese-making process.

Coagulation of the Milk Protein

Coagulation of the milk protein or casein is necessary to separate the curd from the whey. Depending on the cheese variety, coagulation may involve culturing with special bacteria, enzymes (rennet), or a combination of the two. Cheeses that are consumed fresh are usually made by culturing the milk with bacteria, while cheeses that are aged are usually made using enzymes.

Separating the Curd from the Whey

Cheese variety influences when the coagulated protein, or curd, is separated from the whey. Commercial cheese makers separate the curd by using metal frames and mesh-like wire that fits directly into their cheese vat. The wire is moved across the vat, and the curd is cut into cubes. After the curd is cut, the cubes are left undisturbed to increase firmness. Once the cubes have reached the desired firmness, the excess whey is drained from the vat.

Aging

While all of the processes discussed above influence the flavor, texture, and quality of cheese, the aging process has the most influence on the final cheese variety. The purpose of aging is to develop a specific flavor, body, and texture. Microorganisms and enzymes that are active in the coagulation step also influence the ripening of the cheese. Salt is a very common ingredient added to cheese to enhance flavor.

Varieties of Cheese

Today, cheese is available in hundreds of varieties, types, and flavors. Variation in the steps of the cheese-making process determine the final type of cheese produced. When talking about variety, goat cheese can be classified either as ripened or unripened (fresh). Ripening is a classification of how long a cheese has been aged. Typically “younger” cheeses, or unripened cheeses, are whiter in color than ripened cheeses, which are a creamier color.

In addition to age classification, cheese can be further separated by moisture content and classified as soft, semisoft, firm, or hard. Generally, a drier, or harder, cheese has a stronger flavor than a more moist variety.



Other Value-Added Products

While cheese production is a very important use of goat milk, the milk can also be used for a number of other uses, including yogurt, dried powder, and fudge. Besides food products, goat milk is commonly used to make cosmetic and hygiene products, such as soap, bath soaks, and lotion. These products are commonly seen at farmers' markets, craft sales, and even some up-scale department stores.

