Learning About Dairy

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UNIVERSITY OF MINNESOTA | EXTENSION

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Breed History

Dairy Cattle Terms

Registered animals are officially recorded in the breed association herd book. Generally, animals need to be 87% (7/8) of the breed they are being registered in to be considered for breed awards or participate in the show ring.

Purebred dairy cattle generally refers to registered animals. However, non-registered or grade animals that have the characteristics of a breed and several generations of ancestors of that breed may be considered purebreds.

Grade dairy cattle are not registered in any breed association herd book but are usually purebreds that have the characteristics of a breed. Grades also include crossbred animals. Grade animals are usually ineligible for registration directly to the herdbook because their parents were not registered.

Herd book is the official ancestry record of registered animals of a breed kept by the breed association.

Closed herd book is a breed association's policy to restrict registration to offspring of animals already registered.

Open herd book is a breed association's policy to permit offspring from non-registered parents (grade purebred) to be registered. There may be a multi-step process where registered sires must be used for several generations before offspring receive full or provisional registry status. Most U.S. dairy breeds currently have open herd books.

Crossbreeds have parents and/or close ancestors of different breeds.

Dairy Cattle Organizations

Dairy Herd Improvement Associations (DHIA) are organized in all 50 states. DHIA computerized dairy production records for cows and herds help dairy producers manage their herds and select the best breeding stock. Details of the DHIA program can be obtained from your county extension educator.

The U.S.D.A. (United States Department of Agriculture), the State University Extension Service, and the state and local DHI associations cooperate to provide this service to producers.

The national genetic evaluation program uses DHI records to determine predicted transmitting ability. These genetic evaluations are used universally by breed associations, artificial breeding organizations, and dairy producers to select the best animals for their breeding programs. Genetic evaluations can be found on the USDA's Animal Improvement Programs Laboratory at the web site http://aipl.arsusda.gov/.

The *Purebred Dairy Cattle Association (PDCA)* is sponsored by the registered dairy breed associations in the United States. It promotes interest in registered dairy cattle. It also helps establish uniform policies and procedures for official production records, artificial breeding, uniform score card for fitting and showing contests, showing procedures, and ethics for public and private sales of registered dairy cattle. The PDCA is a federation of seven dairy breeds in the U.S.: Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, Milking Shorthorn, and Red and White.

Purebred Dairy Cattle Association (PDCA)
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Madison, WI 53713
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Discovering the Cow

Dairy cows didn't always produce as much or look like the ones we see today. Long ago, there were cows of many shapes and sizes. Some had long shaggy hair; others were sleek and smooth. Some had humps over their shoulders; others had straight backs. Cows were many sizes, shapes, and colors. They roamed wild. People hunted them as they moved around searching for food.

Later people learned that many wild animals could be kept as pets or to supply food. The animals were used for food and for clothing. Ancient drawings show that people tamed dogs, sheep, and cows. Later, they tamed cats and horses.

As time passed, people learned how good and nutritious milk was. They also discovered how to make butter and cheese from milk. People wanted to learn how to get cows to produce large amounts of milk.

These people found some cows gave more milk than others. They discovered that cows produced more milk when they were fed good pasture land. Cows that gave the least milk were used for meat, and the best milkers were kept. This is how people began to change the cow - those that were kept had the most calves. Many, many years passed before the present breeds of cattle appeared.

There were no cattle in America when Columbus landed in 1492. Early settlers brought dual purpose cattle with them to provide meat and milk, and serve as draft animals. Our current breeds of dairy cattle were imported from their native lands in greatest numbers between the years 1860 and 1880. There have been only about 30 to 40 generations of breeding since our six dairy breeds were established in the United States. Even so, the conformation of the animals has changed markedly and we have seen a tremendous increase in production.

Getting to Know the Breeds

Ayrshire

Breed History

The Ayrshire breed originated in the County of Ayr, Scotland before 1800. It was known as the Cunningham, the Dunlop, and finally, the Ayrshire. The breed was developed from native stock through long-term selection for hardiness, superior udders, and efficient milk production. Countries in the world where Ayrshires are primarily found today include Scotland, the United States, and Canada. Finnish Ayrshires, Norwegian Reds, and Swedish Red and Whites are breeds with 60 to 95% Ayrshire ancestry.

H. W. Hills of Windsor, CT imported the first Ayrshire into the United States. That was in 1822. The number of Ayrshires imported is small compared to those of most breeds. The states having the greatest numbers of Ayrshires include New York, Pennsylvania, Vermont, Iowa, Ohio, Illinois, and Wisconsin.

U.S. Breed Association Office

Executive Secretary
Ayrshire Breeders' Association
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Email: info@usayrshire.com
http://www.usayrshire.com/

Breed Characteristics and Notes

Ayrshires are deep cherry red, mahogany, brown, or a combination of any of these colors with white or pure white. A mature cow should weigh at least 1,200 pounds.

Ayrshires are characterized by strongly attached, evenly balanced, well shaped udders. Ayrshires have a reputation for having a strong constitution and vigor. They are known for their fertility, overall health, and resistance to mastitis. Ayrshires are also are known to be efficient grazers.

The biggest challenge that the Ayrshire breed faces is to increase milk production per cow. The number of Ayrshires in the U.S. have been too small to progeny test enough young sires to maintain the amount of genetic progress enjoyed by the larger breeds. However, recent changes in registry rules allow U.S. Ayrshire breeders access to semen from the Scandinavian Red breeds which have had very progressive progeny testing programs for many years. To be eligible for breed shows and awards, offspring must be at least 87.5% Ayrshire ancestry.

Brown Swiss

Breed History

The Brown Swiss breed is one of the oldest of the dairy breeds in the world. The breed has descended from the cattle used in the valleys and mountain slopes of Switzerland before historical records began. Cattle bones found in the ruins of the Swiss Lake Dwellers indicate cattle closely related to Brown Swiss of today existed during the Bronze Age. Early Swiss farmers gave great attention to cattle breeding and much effort was made toward locating the best cows and bulls in the country. Apparently, no crossing with other cattle not distinctly Brown Swiss was allowed in the establishment of the breed.

The grazing areas in native Switzerland were high above sea level (3,000 to 8,500 feet) and were often over steep terrain. The unusual physical exertions and high altitude under which the breed evolved over centuries has probably played an important role in the strength, hardiness and ruggedness found in the Brown Swiss breed today.

The first recorded Brown Swiss in the United States, one bull and seven females, were imported 1869. Two of the females were pregnant at the time of importation, which resulted in another bull and heifer being born. From these ten animals, 251 descendants were recorded in the Brown Swiss Record before the next importation of animals in 1882. In all, about 25 bulls and 130 Brown Swiss cows were imported into the United States, which was fewer imports than any other major dairy breed.

The breed expanded rapidly across the United States and while numbers were increasing, breeders also were selecting for increased production and type. The breed had to overcome several setbacks. Many top Brown Swiss herds in the early 1900s were destroyed because of outbreaks of foot-and-mouth disease and tuberculosis. Another setback was in the 1980s when the recessive genetic defect for the "Weavers" condition was found in several of the top Brown Swiss bulls. This was followed with the discovery of another recessive genetic defect, Spinal Muscular Atrophy (SMA) in the breed. By identifying and labeling carriers of these genetic defects, the frequency of these detrimental genes have decreased but it has been a costly process for the breed.

U.S. Breed Association Office

Executive Secretary
Brown Swiss Cattle Breeders' Association
800 Pleasant Street, Beloit, Wisconsin 53511-5456
info@brownswissusa.com
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Breed Characteristics and Notes

Brown Swiss usually are docile, slower moving cows with more heat tolerance than other breeds. Also, they tend to be heavier muscled than other dairy breeds. For this reason, they have been used in beef cattle crossbreeding programs to produce docile cows with increased milk production. Because of their ruggedness and heat tolerance, they have been in high demand for export to Central and South American countries. Brown Swiss are known for their outstanding feet and legs, udders that last, and longevity. The world population of Brown Swiss is about 7 million which makes them the third most numerous dairy breed after Holsteins and Fleckvieh. Large numbers of Brown Swiss can be found in Germany, Italy, Austria, and Switzerland.

The two biggest challenges facing the Brown Swiss breeders are to increase production per cow to more effectively compete with the Holstein breed, and to increase Brown Swiss registrations in the U.S. The Brown Swiss breed was the first breed to allow grade animals to be involved in the breed registry in 1968. In 1993 they revamped the Identity Enrollment (I.E.) program to include matings of any dairy animal to a registered Brown Swiss. After five generations of breeding to registered Brown Swiss sires, resulting animals are allowed in the official herdbook.

LaRainbow Bfly Sunkist ET
2019 Total Performance Cow

Cutting Edge T Delilah
2019 Supreme Champion WDE

Fleckvieh

Breed History

Fleckvieh cattle originated in Bavaria (now southern Germany) and Austria in the 1800's. Starting in 1830, Simmentals from Switzerland were imported to cross on the local breeds to improve milk production and muscling. The resulting crosses were selected for milk production, meat, and draught capabilities. A closed herdbook was established in 1920 in Germany and the Fleckvieh was established as a new breed. The breed developed into a dual purpose breed used primarily for the production of milk or beef.

Fleckvieh were first imported into the United States to be used as a beef breed and cross with beef cows. The Fullblood Simmental Fleckvieh Federation was originally established as the American Fullblood Simmental Marketing Committee in 1995. In 2004, it evolved to the Fullblood Simmental Fleckvieh Federation. More recently, Fleckvieh semen has been imported to cross with dairy cows. Bulls selected to use on dairy cows are generally more highly selected for milk production and udder conformation than iimported semen to be used on beef cows.

Breed Characteristics and Notes

The Fleckvieh breed is moderate to large framed with a long, wide and deep body. Mature Fleckvieh cows weigh from 1500 to 1800 lbs. The basic colors of the breed range from light to dark yellow and red to dark red on white. The distribution of colors may be spotted, speckled or most of the body solid colored. An important trademark of the breed is the dominant white head with a broad muzzle. Eye spectacles or eyelid pigmentations occur frequently. and feet enable make them functional for many environments. The breed shows good muscularity throughout their body. Fleckvieh cows have functional udders but have much lower and more narrow rear udder attachments than typical of other dairy breeds.

Fleckvieh females excel at calving ease, fertility, longevity and are easy keepers. Fleckvieh cattle are healthy, hardy and show an excellent adaptability to the different geographical and climatic conditions. Fleckviehs milk components average 4.2% fat and 3.7% protein with a low somatic cell count.

Over 30 million Fleckvieh cattle can be found in central European countries with the most found in Germany. They have a very progressive genomic and progeny testing program with an index very similar to other dairy breeds except that some emphasis is placed on degree of muscling. About 12 million cow performance records are collected for genetic evaluations each year with contributions from Germany, Austria, Czech Republic, France, Italy, and Slovakia. The Fleckvieh is considered the second most numerous breed of Bos Taurus dairy cattle.

When crossing with Holsteins, expect lower milk production and a cow that maintains much more body condition. Compared to Holsteins, the crosses should have higher fertility, slightly higher milk components, fewer health problems, and more robust calves.

Manolo Pp
Top Fleckvieh proven sire 2020.

Ecuador 10/198900
High indexing Fleckvieh dam

Guernsey

Breed History

The Guernsey breed has been called "The Royal Breed" of dairy cattle. Its history traces back 10 centuries to the tiny (24 square miles) Isle of Guernsey in the English Channel off the coast of France. Monks that were sent to colonize the island crossed two famous French breeds of dairy cattle: Fromont du Leo Brittany and Norman Brindles from Normande. Captain Prince of Boston, MA, an American sailing captain, imported the first cow and bull for his brother in New Hampshire in 1831. These were known as the Pillsbury Cow and Bull.

By the 1960s, the Guernsey Breed was the second largest of all dairy breed registries, registering 80,000 animals per year. However, Guernseys have experienced declining registration numbers since the 1960s. By the 1990s, Guernseys were below Holsteins, Jerseys, and Brown Swiss in total registration numbers. The states having the greatest number of Guernsey cattle are Wisconsin, Pennsylvania, California, New York, Ohio, Minnesota, and Indiana. At 350 cows, Hoards Dairyman maintains one of the largest Guernsey herds in the nation.

U.S. Breed Association Office

Executive Secretary
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Breed Characteristics and Notes

The Guernsey is a shade of fawn, either solid or with white markings, with golden yellow pigmentation. The breed is moderate in size; desired mature cows in early lactation average 1,150 pounds and stand approximately 53 inches at the withers. The Guernsey is noted for the superior flavor of its golden-colored milk - naturally high in all milk solids. Guernsey milk has a higher level of beta-carotene content which gives it its golden color. Breeders have capitalized on this by promoting their trademark Golden Guernsey milk sales. Guernseys are widely known for their calm and docile dispositions and relatively good calving ease.

The challenges facing the Guernsey breed are to increase milk production and number of registrations. This will be extremely difficult to do. A severe disadvantage that the Guernsey breed has is that there are very few Guernseys outside to the U.S. so there is nowhere else to aid in genetic improvement. The breed association has a Genetic Recovery Program that allows registration of offspring from grade cows after a few generations of mating to registered Guernsey sires.

Holstein

Breed History

The Holstein-Friesian breed began in the kingdom of the Netherlands. It is generally accepted that the Friesians and Batavians brought their cattle with them when they first settled the fertile lowlands of the Rhine delta at the beginning of the Christian era. The intermingling of their cattle finally evolved a black and white breed. It is believed that the generally unmixed breeding of these cattle in Holland contributed to foundations for the Shorthorn, Ayrshire, and Guernsey breeds.

Dutch settlers to New York probably brought the first animals to America in about 1621, but their breeding had no influence on the breed, as no official herdbook was established. The official beginning of the breed in America dates to Winthrop W. Chenery of Belmont, MA, when he bought some cows imported by a Dutch sailing master in 1852. "Dowager," one of the first cows imported, completed a record of 12,681 pounds and 8 ounces of milk. Chenery was so impressed with Dowager that he made more importations of Holsteins in 1857, 1859, and 1861. Many other breeders soon began to import and trade Holsteins and the official herdbook was established for Holsteins in America in the early 1880s. In all, about 8,800 Holsteins were imported into the United States. Importations ceased after foot and mouth disease broke out in Europe.

U.S. Breed Association Office

Executive Secretary
Holstein Association USA, Inc.
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(800) 952-5200
http://www.holsteinusa.com/

Breed Characteristics and Notes

Today's Holstein cow is a large, stylish animal, with outstanding milk producing capability and distinctive color markings of black and white or red and white.

A healthy, newborn Holstein calf will weigh 90 pounds or more at birth. A mature cow in milk should weigh about 1,500 pounds and stand 58 inches at the withers.

More than 80 percent of the registered cattle in the U.S. are Holsteins. Including grades, Holsteins make up over 80 percent of the cows milked in the U.S. In addition, Holsteins have gained increased popularity around the world. Holsteins can be found in almost every country.

The reasons for the Holstein cow's popularity is because Holsteins exceled for total milk production and income per cow. Holsteins are known for their vigorous appetites and adaptability to a wide range of conditions. Cull cows and males not kept for breeding purposes provide an additional source of income on the beef market. However, with the emphasis in increased milk production, fertility and hardiness of the Holstein has decreased from 1960 to 2010. Much progress has been made in the Holstein breed over the last ten years in the health and fitness traits because of increased emphasis on those traits in the index and very aggressive use of genomic testing.

The future looks great for the Holstein breed. More animals are genomically tested than the rest of the breeds combined, which has enabled the Holstein breed to excel in genetic improvement for fitness and health traits as well as milk production. Genomic genetic evaluations are more accurate for Holsteins than the other breeds because of their superiority in number of animals tested.

Mountfield Ssi Dcy Mogul-ET: Influential Sire

Jersey

Breed History

The Jersey breed has a romantic and adventuresome history, as does the Isle of Jersey in the English Channel. Before 709 A.D., this island was connected by a land bridge to the mainland of France. There are many interesting theories of where the original cattle that formed the breed came from; one contends the Jersey originated in India and migrated across the land bridge, another that Jerseys came from the early stock of Brown Swiss of Alpine origin, and a third that they are a refinement of the Normande and Brittany spotted cattle. The precise details of the evolution of the breed before 1800 is unknown.

The earliest record of Jerseys imported to America dates to 1815. Today the states with the largest numbers of Jerseys are California, Ohio, Vermont, Oregon, Tennessee, Wisconsin, New York, and Texas. About 16% of the dairy cattle registrations in the U.S. were Jerseys in 2019.

U.S. Breed Association Office

Executive Secretary
The American Jersey Cattle Club
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(614) 861-3636
http://usjersey.com/

Breed Characteristics and Notes

Jerseys vary greatly in color, but the characteristic color is a shade of fawn with or without white markings. The muzzle is black encircled by a light colored ring, and the tongue and switch may be either white or black. Jerseys are more refined and display more dairy character than other breeds. They are the smallest dairy breed, with a mature size of about 1,000 pounds.

Strengths of the breed include excellent heat tolerance, high fertility, young age at first calving, calving ease, and high pounds of milk solids produced per pound of feed consumed.

The Jersey breed has been considered by many as the most progressive in recent decades. Since the 1970s, they have a greater percentage increase in number of registrations than any other breed. Highlights of the organization's progressive attitude include early adoption of a grade genetic recovery program (3 generation program in which offspring of grade Jerseys can reach full registry status), early endorsement of USDA's Predicted Differences for Production (now PTAs), selection for functional type, and formation of a Jersey Marketing Service. In addition, the Jersey organization is the only breed association with a separate and full-time organization devoted to milk marketing. The National All-Jersey was formed in 1957 to increase the demand for Jersey milk. One of their achievements was the promotion of multiple component pricing of milk, which has raised income to Jersey farmers because of the high protein percentage found in Jersey milk. Jersey breeders have had the opportunity is recent years to import semen from outstanding Jersey bulls from Denmark. In addition to increasing genetic progress for all of the production and health traits, the influx of new genetics has broadened the genetic base and helped lower the increase in average inbreeding levels.

551JE1650 Got Maid: Top NM$ Bull, August 2020

Got Maid daughters

Milking Shorthorn

Breed History

Milking Shorthorn originated in northeastern England in the valley of the Tees River. In 1783, the first "milk breed" Shorthorns entered the U.S. in the State of Virginia. Early settlers referred to these cattle as "Durhams." They became the favorites of pioneers because they offered meat, milk and power.

The first American Shorthorn Breeders' Association was formed in 1882 to promote both Milking and Scotch (beef) Shorthorns. In 1912, a group of Milking Shorthorn breeders formed the Milking Shorthorn Club to work within the American Shorthorn Breeders' Association. The Milking Shorthorn and beef Shorthorn organization split in 1948 when the American Milking Shorthorn Society was incorporated and took over registration and promotion of the Milking Shorthorn breed.

U.S. Breed Association Office

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The American Milking Shorthorn Society
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milkshorthorns@tds.net
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Breed Characteristics and Notes

Shorthorns are either red, red and white, or roan. Roan is a very close mixture of red and white and is found in no other breed of cattle. Animals may be either horned or polled (without horns). The color and horned condition are indicated in the certificate of registry. The breed is intermediate to large in size with cows being approximately 54 inches at the withers and weighing 1,400 to 1,600 pounds in average condition.

The Milking Shorthorn has made tremendous progress in milk production in the past 40 years. This was due to an effective progeny testing program, the incorporation of genes from other breeds, and allowing animals from other countries into the herdbook. Milking Shorthorns are known for their excellent reproductive efficiency and longevity. They also are fairly heat tolerant. Bulls not kept for breeding are successfully fed for beef and hang beefy, high-quality carcasses.

The Milking Shorthorn Society's Genetic Expansion Program allows characteristic Milking Shorthorns into the official herdbook and also enables breeders to introduce outside dairy genetics into the breed. A continuing challenge of the Milking Shorthorn breeders will be to continue to select animals for increased Net Merit Dollars to lessen the gap between them and the other major dairy breeds and to not overemphasize show ring type at the expense of the production traits

Montbeliarde

Breed History

The Montbeliarde breed originated in the Montbeliarde region of France. The breed is also known as French Dairy Simmental – even though they are not related to the beef Simmental. The breed evolved in eastern France in the 1800s from two local populations (Femelline and Comtoise) along with the Red of Bern breed imported from Switzerland. Montbeliardes were first known as Franco-Swiss cattle. Joseph Graber first used the term Montbeliarde in 1872. The breed was officially adopted in 1889 and a herd book was created. The breed association was established in 1901 in Besancon, France. Selection for milk production was the main emphasis of the breeders from the inception of the breed. Over the last 40 years, they have been a very progressive breed; progeny testing 150 to 175 young sires per year, adopted an index with 50% of the weight on production and 50% on health traits and udder and foot and leg conformation, and are presently investing heavily in genomics. Monbeliard genetics were first introduced into the US by imported semen and crossbreeding with Holsteins in the 1970's. Montbeliarde's provided improved strength, fertility and hybrid vigor when crossed. The Montbeliarde breed has also been used in other breeds such as Danish Red and Vorderwalder.

Breed Association Office

Executive Secretary
P.O. Box 449
Montbeliarde, France 53512
(608) 365-3332

Breed Characteristics and Notes

The animals are red pied with a white head and of dairy type. Montbeliarde's have lower milk yields and don't have the extreme dairyness of modern Holsteins but have better longevity and fertility and lower cell counts in the milk indicating lower mastitis incidence. Mature cows usually weigh 1300-1500 pounds and are about 54" tall. Mature bulls usually weigh 2000-2500 pounds. These cattle are known for having good feet and legs. The milk is especially good for making cheese because of the high protein levels in the milk. They can also be used as beef animals for their meat. The bull calves are worth more than Holsteins. Montbeliardes are being used to cross with Holsteins. These crossbreds have been shown to have increased fertility and longevity. They are the 2nd most popular breed of cattle in France. In France they average slightly over 16,000 pounds of milk with 3.9% fat and 3.4% protein. Cull cows are also very good for meat.

One Million
#1 Monbeliarde Index Bull June 2020

Normande

Breed History

Normande cattle originated in the Normande region of France. They descended from cattle that were brought there by the Vikings. The herd book was started in 1883. During the World War II invasion the numbers of Normandes were severely decreased. Now there are about 3 million Normandes in France. Normande dairy producers in France enjoy a premium price for both Normande beef and milk. The Normande beef is sold as a branded meat product and the milk is made into a premium soft cheese. Normande milk excels for soft cheese production because it makes a firmer curd than milk from other breeds. The first Normandes were imported into the United States in 1974 and first promoted as a beef breed and later as a dairy breed to cross on Jerseys and Holsteins. They have also been brought to other countries around the world, mainly in South America – with Columbia now being the number one country in Normandes worldwide.

U.S. Breed Association Office

North American Normande Association
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800-573-6254 or 608-943-6091
http://www.normandeassociation.com/

Breed Characteristics and Notes

Normandes have good fertility, longevity, and udder conformation. Normandes also calve easy due to a large pelvic area. They also tend to have healthy calves. Mature cows weigh 1200-1500 pounds. Bulls weigh 2000-2400 pounds. They average 14,000 pounds of milk per lactation with a 4.2% fat test and a 3.5% protein test. They also have a high yield percentage at slaughter. Normandes can be a brown and white or black and white in color. Because of their high meat yield, they are often referred to as dual purpose; however, most of the genetic selection pressure has been for milk production. Normande's are used in crossbreeding programs and seem to especially fit in well for dairy producers that graze their cows.

Red and Whites

Breed History

In 1964 the Red And White Dairy Cattle Association began to register cattle in their herd book. The association was started by Milking Shorthorn breeders. They then wanted to breed their cattle to Red and White Holsteins to improve milk production. They chose Red and White Holsteins because they are also red. The Red and White Dairy Cattle Association has always had an open herd book. The herdbook consists of two divisions, the Red Registry and the Extended Registry. Animals must be Red and White for the Red Registry. The Extended Registry is for Animals that do not meet the color requirements for the Reg Registry. The following have been accepted as Approved Breeds: Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, Milking Shorthorn, Red Dane, Angler, Swedish Red, Norwegian Red, Illawarra, Aussie Red, Rouge Flammande, Normande, Lineback, Meuse-Rhine-Issel, Dutch Belted, Gelbvieh, Red Poll, Simmental, White Park, and Montbeliarde. Today, Red and Whites are comprised mostly of Red and White Holstein genetics and show ring type seems to be the main focus of the breed.

U.S. Breed Association Office

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http://www.redandwhitecattle.com/

Breed Characteristics and Notes

Red and Whites are red and white in color.

Swedish Red and White

Breed History

Swedish Red and White started as Ayrshire and Milking Shorthorn cattle imported from England into the Scandinavian Countries of Norway Sweden, Finland and Denmark. This went on from 1847-1920. In 1890 two breed associations were started. One for the imported Ayrshires and one for the imported Milking Shorthorns. These two associations merged in 1928 and is know as the Association for Swedish Red and White Cattle. They are commonly known as Swedish Reds. Semen was exchanged between Swedish Reds, Ayrshires in Finland and Norwegian Reds in Norway. Swedish Reds are the most common dairy breed in the Scandinavian Countries.

Breed Association

www.srb-foreningen.se
Swedish Red Association
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Breed Characteristics and Notes

Early on Swedish Red breeders recognized that maximizing profit was more than just high milk productions. They believed cows should efficiently produce milk and meat, be healthy, get pregnant, give birth to healthy calves without calving difficulties, work well in the herd and be easy to handle. Because of this, in 1975, Swedish Red was the first breed to select for health traits such as high fertility, disease resistance and low somatic cell count. The goal was to produce a breed that was high producing, even under diverse conditions. The unique calving ease, good udder health and good fertility is a strength of the breed.

Swedish Red cattle are mostly red. Few have white markings. They average about 19,000 pounds of milk a lactation with 800 pounds of fat and 700 pounds of protein. .

Scandinavian Red Breeds

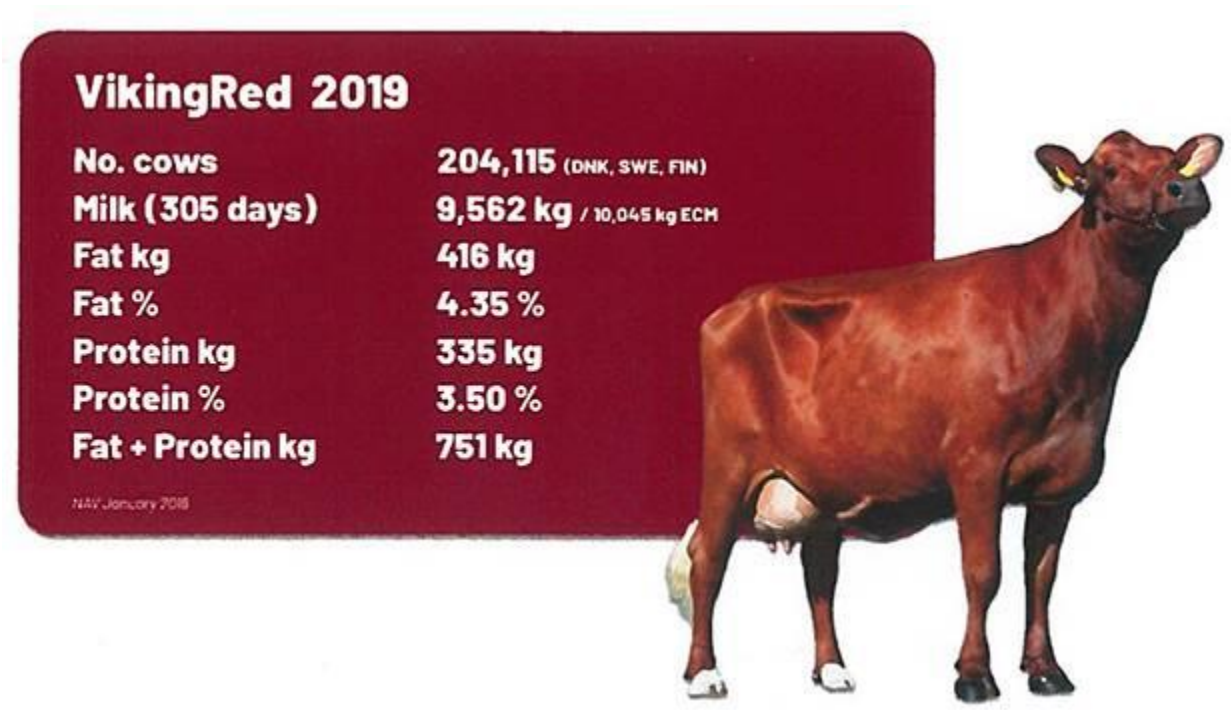
History

The Scandinavian Red Breeds include Swedish Red and White, Norwegian Red, Finnish Ayrshire, and the Danish Red breeds. All of these breeds share an Ayrshire ancestry but mixed in other breeds, including small native populations. DNA analysis of individual animals within these breeds shows Ayrshire ancestry to range from 50 to 95%. The Swedish Red and White breed was formed by merging the Ayrshire and Milking Shorthorn breed associations in 1928. The Norwegian Red breed includes a small amount of Holstein genetics. The Finnish Ayrshire has the highest percentage of Ayrshire genetics. In addition to these breeds, the Danish Red added a small amount of Red and White Holstein, Jersey and Brown Swiss to the mix in recent years. The Scandinavian Red breeds have had excellent progeny testing programs for many years. The Norwegian Red and Swedish Red and White breeds were among the first to develop an index that put major emphasis on the health traits such as mastitis resistance and fertility. Today, these four breeds share semen and genetics to some extent. There is a movement to reduce the influence of Holstein within the breeds.

The Swedish Red and White, Finnish Ayshire, and Danish Red breeds combined to form one breed, called Viking Red. These Scandinavian countries decided that they can make even more genetic progress if they work together as one breed.

Breed Characteristics and Notes

The Scandinavian breeds are noted for their health, vigor, fertility, longevity and calving ease. Milk production is lower than the Holstein but much higher than the American Ayrshire. They have excellent udder conformation. They have sound, healthy feet and legs but on average may exhibit more set to the hock than is thought to be most desirable. They tend to carry more condition and be a little rounder over than shoulders than we generally desire for the show ring. Emphasis has been on functional type rather than show ring type. Cows tend to be mostly red with some white markings. The Norwegian Red breed has put additional effort on selecting for the polled gene.



Dairy Cattle Genetics

How's and Why's of Inheritance

A cow, like other animals, is composed of billions of cells. Each cell contains 30 pairs of chromosomes, or 60 total chromosomes. Located on the chromosomes are thousands of units of heredity known as genes. Alternative forms of a gene at a loci are called alleles. The genes or genetic makeup of an animal determine the animal's physical appearance and influence behavior and production traits throughout the animal's life.

During reproductive cell division in the testes of the male and ovaries of the female, the primary reproductive cells divide so that only one member of each pair of chromosomes goes into the new cells. The new cells, which evolve into the sperm and egg, contain one-half of the complete genetic material. When the sperm of the male and egg of the female unite, the resulting embryo has the full complement of genetic material—one-half from the mother and one-half from the father.

The single celled embryo divides into two identical cells, then again into 4, 8, 16, 32, 64, and continues until millions of cells are formed. As they divide, some become skin cells, others become nerve cells, muscle cells, the digestive tract cells, and so on to form all parts of an animal's body. This all is controlled by the genetic code present in each cell.

Characteristics of an animal are known as traits. The inheritance of traits can be simple or can be rather complex, depending upon the trait. An example of a simply inherited trait is the polled vs. horned condition in cattle. Most dairy cows are dehorned as calves but some are born naturally polled (without horns). Let's say that the polled condition is determined by the "P" allele, and the horned condition is determined by the "p" allele. Since genes occur in pairs, the possible genotypes of an individual include "PP," "Pp," and "pp." A "PP" individual would be naturally polled. A "pp" individual would be horned. Because the "P" allele is dominant over the "p" allele, "Pp" individuals would be polled but carriers for the horned allele. While there are some polled individuals in each dairy breed, most dairy animals are genetically horned and of the "pp" genotype.

Another simply inherited trait is the gene for Holstein coat color. There are four alleles at the recessive red loci. In order of Dominance are E^D - black and white coat color; E^{BR} - black/red - born red and turn black over time, sometimes retaining some red coloring around the nose, ears and down their topline, also known as Telstar Red, E^+ - Wild-type red produces cattle with red and white coloration that may appear darker towards the extremities of the body, especially as the animal ages. "e" codes for red and white. Following are a few possible matings and frequencies of each offspring.

Parent Genotypes	Progeny Genotype	Progeny Appearance
E^DE^D x E^DE^{BR}	½ E^DE^D, ½ E^DE^{BR}	All Black and White
E^DE^{BR} x E^DE^{BR}	¼ E^DE^D, ½ E^DE^{BR}, ¼ $E^{BR}E^{BR}$	3/4 Black and White and ¼ Telstar Red
$E^{BR}E^+$ x $E^{BR}E^+$	¼ $E^{BR}E^{BR}$, ½ E^+E^{BR}, ¼ E^+E^+	3/4 Telstar Red and ¼ Wild-type Red
E^+e x E^+e	¼ E^+E^+, ½ E^+e, ¼ ee	3/4 Wild-type Red and ¼ Red and White
E^De x E^+e	¼ E^DE^+, ¼ E^De, ¼ E^+e, ¼ ee	½ B&W, ¼ Wild-type Red and ¼ Red and White
$E^{BR}e$ x E+e	¼ $E^{BR}E^+$, ¼ $E^{BR}e$, ¼ E^+e, ¼ ee	½ Telstar Red, ¼ Wild-type Red and ¼ Red and White

In addition to the recessive red loci there is the Dominant Red gene that traces back to a Canadian cow named Suriname Sheik Rosabel-Red. At this loci the red allele is dominant over the black allele and dominant over the alleles at the recessive red loci.

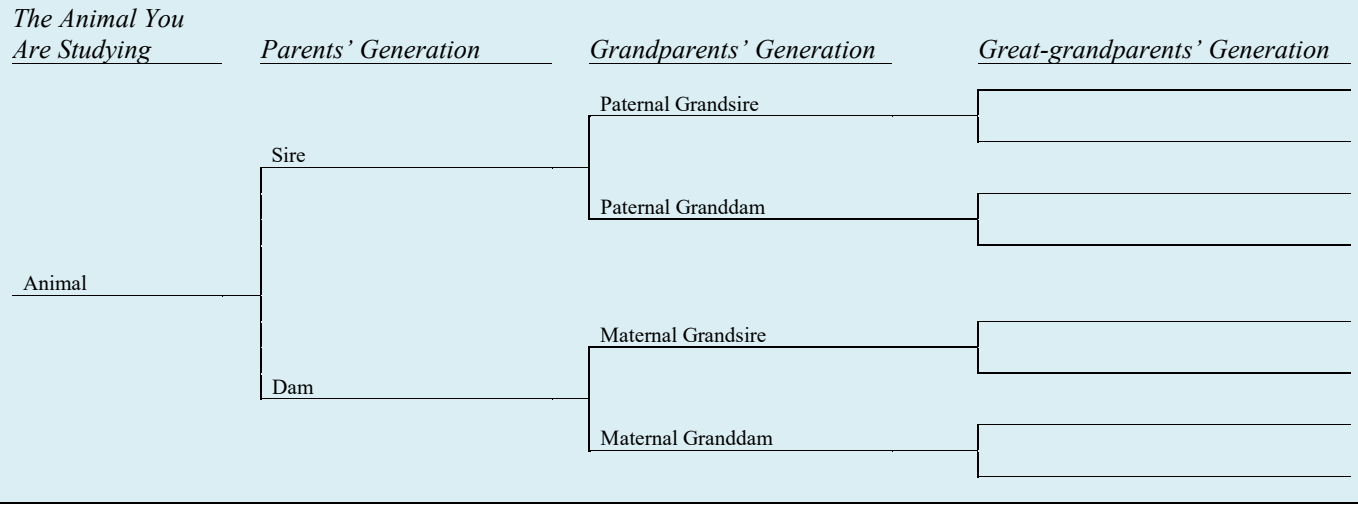
Genetic defects tend to be simply inherited. The normal gene also tends to be dominant over the defective gene. In other words, for the trait to be expressed, the animal needs to receive a defective gene from both its father and mother. The parents are normal but carry the hidden defective gene. Examples of genetic defects in dairy cattle include BLAD, CVM, Brachyspina, and DUMPS in Holsteins, Brown Swiss and Jerseys; limber leg and RVC in Jerseys; Weavers in Brown Swiss; and Mulefoot in Holsteins.

Traits that are more complex in their inheritance include milk production, reproduction, mastitis resistance, growth rate, and conformation. Rather than controlled by a pair of genes, these traits are influenced by thousands of gene pairs. In addition to being influenced by many genes, these complex traits also are influenced greatly by the environment. Environmental factors that may influence a cow's production record include feed quality, milking management, ventilation, temperature, stall comfort, measurement errors, exposure to disease organisms, and competition from other cows. For most complex traits, environment accounts for more variation in the animal's performance than genetics.

Because of the many environment influences, it is difficult to tell which cows are best genetically by just comparing their actual production records. A cow with average genetics but a superior environment could have a top record. On the other hand, a genetically superior cow in a poor environment probably would have a mediocre record. Using all available DHIA records from an animal and its relatives, the USDA publishes Predicted Transmitting Abilities (PTAs) for different production traits in an attempt to genetically rank the animals. Complicated statistical programs and high speed computers are used to remove as much of the environmental influences as possible so that the best estimate of an animal's genetic value can be obtained. Along with the PTAs comes a measure of their accuracy known as the reliability. Reliabilities range from 20 to 99% depending upon how much information is available on that animal. Regardless of the reliability level, the PTA is always a better indication of that animal's true genetic level than is the animal's actual performance.

Understanding Pedigrees

The dairy animal's family tree or record of ancestry is known as the pedigree.



An animal gets half of its genes from each parent. Grandparents contribute one-fourth on average and great-grandparents only contribute one-eighth on average. Pedigrees were studied in detail by dairy breeders in the past to evaluate an animal's potential ability, which might be inherited from parents, grandparents, and more distant relatives. Often too much emphasis was placed on distant relatives. On average, only one-eighth of the genes between an animal and great-grandparent would be expected to be in common. Today, an animal's PTA already takes into account its ancestors' records so there is little need to study the ancestors' performance. The most practical reason to look at an animal's pedigree is to help avoid inbreeding when making mating decisions.

Sample Pedigree

																							GTPI
																	O-BEE Manfred Justice-ET						2124
																	USA 122358313 100% RHA-NA						
																	PTA	841M	69F	50P	99%R		
																	PTA	724NM	.14%F	.09%P			
																	PTA	5.3PL	2.69SCS	2.5DPR	3%DCE		
																	PTA	.19T	-.21UDC	+1.11FLC	99%R		
																TPI							CTPI
1.	Rivendale Latte															1968	Rivendale Coco						1699
2.	USA 14339701 100% RHA-NA																USA 106433955 100% RHA-NA						
3.	2-01 82 VEVV+																2-02 86 +EVVV						
4.	PTA	+1401M	+57F	+60P	50%R												PTA	368NM	+.00%F	+.01%P			
5.	PTA	501NM	+.01%F	+.00%P													PTA	+.5PL	2.92SCS	.1DPR	8%DCE		
6.	PTA	+1.5PL	2.88SCS	+.4DPR	10%DCE												PTA	+.80T	+1.01UDC	+1.31FLC	60%R		
	AGE	X	DAYS	MILK	DCRM	%	FAT	%	PRT	DCRC							AGE	X	DAYS	MILK	DCRM	%	FAT	%	PRT	DCRC
8.	2-00	2	305	25650	94	3.7	948	3.2	820	94							2-00	2	305	24920	93	3.8	944	3.1	775	93%

Latte, from the pedigree on the previous page, is a Holstein cow with one record completed. Let's go line by line through the left side of the pedigree and explain what the numbers mean.

1. "Rivendale Latte" is the cow's registration name. TPI stands for Total Performance Index. The TPI combines the following PTAs with the relative weightings as of August 2015:

Protein	27%	Productive Life	7%
Fat	16%	Somatic Cell Score	-5%
Type	8%	Fertility Index	13%
Dairy Form	-1%	Direct Calving Ease	-2%
Udder Composite	11%	Direct Stillbirths	-1%
Foot/Leg Composite	6%	Feed Efficiency	3%

2. Latte's national code is USA and registration number is 14339701. Her pedigree is 100% Registered Holstein in the North American Herdbook.

3. Her last type classification was at 2 years and 1 month of age. She classified 82 points and the type breakdown was very good for frame, excellent for dairy character, very good for body capacity and foot/leg composite, and good plus for udder.

4. PTA stands for predicted transmitting ability and estimates the genetic superiority or inferiority that an animal will transmit to offspring. The values are differences from a base population. The best way to use PTAs is to compare and rank animals. Latte has a

PTA of +1401 lb milk, +57 lb fat, and +60 lb protein. The reliability (or accuracy) of these PTAs is 50%. The reliabilities of PTAs for cows are generally lower than reliabilities of progeny tested bulls. The PTAs are computed from Latte's production records plus the records of all her relatives plus genomic information if she was genotyped.

5. Latte's PTA for Lifetime Net Merit Dollar Value (NM) is $501. NM combines the following PTAs with the relative weightings as of August 2020:

Milk	-1%	Udder Composite	7%
Protein	17%	Foot/Leg Composite	3%
Fat	27%	Body Size	-5%
Productive Life	12%	Fertility	10%
Livability	7%	Health	2%
Somatic Cell Score	-4%	Calving Ability	5%

Latte has an estimated genetic transmitting ability of +.01 for percent fat and +.00 for percent protein.

6. The PTA for Productive Life (PL) is +1.5 months, for Somatic Cell Score (SCS), 2.88 (3.00 is breed average; Latte is better than average for SCS since a low number is better), for daughter pregnancy rate (DPR), +.4%; for direct calving ease (DCE), 10%, which relates to chance of difficult births. The average DCE is 9%, so Latte's evaluation for calving ease is slightly poorer than average.

7. Latte's PTAT (Type) is +.35. Her PTA for udder composite is +.75, and for foot/leg composite it is +1.56 with a reliability of 50%.

8. This is Latte's first lactation record. The record started when Latte freshened at 2 years and 0 months of age. She was milked twice daily and, in 305 days, produced 25,650 lb of milk with a 3.7% fat test, 948 lb of fat, a 3.2% protein test, and 820 lb of protein. DCRM and DCRC stand for Data Collection Rating for Milk and Components, which is data quality score influenced largely by how many times Latte was DHI tested during the lactation.

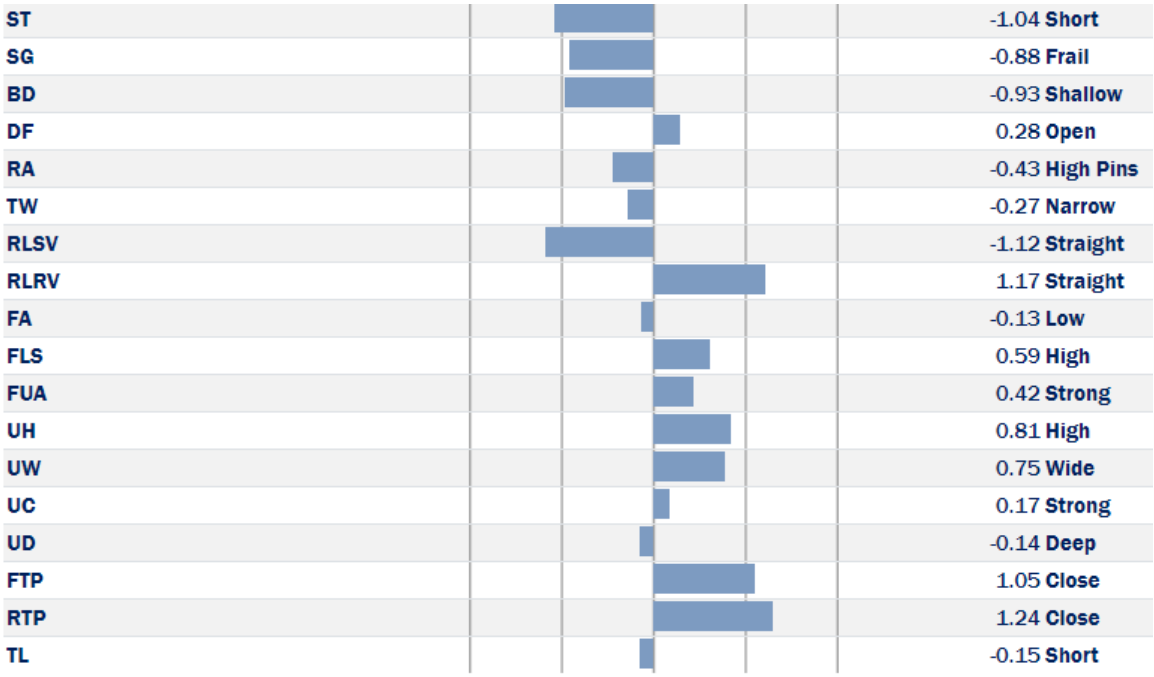
On the right-hand side of the pedigree is information on Latte's father and mother. They basically have the same production and type information that Latte has. The PTA values for Latte's parents are already included into Latte's PTAs so no new information is added about her. GTPI of O-BEE Manfred Justice-ET indicates that he was genomically tested.

Choosing Sires

Sire selection is important because it is the main way that new genetics are introduced into a herd and genetic progress is made. First, the decision should be made to use A.I. sires. Research has consistently shown that daughters of A.I. sires milk 1000 lb. more milk per lactation than daughters of natural service bulls. Secondly, consideration should be given to selecting the best A.I. sires for your circumstances.

A.I. sires are evaluated for many different traits. So many, in fact, that it can be hard to understand all the numbers. To help sort things out, the USDA publishes the Lifetime Net Merit Index. Selecting sires on net merit will yield daughters for maximum profit. It is probably the best index for increasing overall efficiency of milk production. Type traits can be very important for registered breeders that merchandise cattle and for success in the show ring. The predicted transmitting ability for type (PTAT) ranks the bulls on genetic level for overall type score. In addition, there are about 18 linear type traits as illustrated below.

Linear Type Trait Evaluation for ABS Achiever (High Proven Bull for NM$ August 2020)



Linear type evaluations can give a good picture of the type pattern a bull transmits. For example, Achiever's daughters average a little below average in stature with average dairy form. He is above average in most udder traits. Linear type traits have varying levels of importance depending upon the environment of the daughters. There is no optimal level for each trait that will fit all circumstances. A few of the more important traits includes the following:

Udder Depth (UD): Generally, it is desirable to have cows with shallow udders. But, high production bulls tend to have deeper-uddered daughters and should not be automatically eliminated just because their PTA for udder depth is below average.

Stature (ST): Moderate sized cows seem to have the longest productive lives in most management situations. Commercial dairy producers tend to discriminate against really tall cows

Foot Angle (FA): Cows with a steeper foot angle are preferred.

Teat Placement (FTP & RTP): Closer front teats are desired but if robotic milkers are used, rear teats can be too close.

Fore Udder Attachment (FUA): A strong fore-udder attachment is desired over a loose fore-udder.

Dairy Form: Cows with higher dairy form tend to be too thin for optimal fertility.

The rest of the linear traits have not been found to have much correlation or relationship with length of productive life, at least in average management situations encountered in U.S. dairies. There are two key points to remember in using type traits:

1. Initial screening of bulls should be for Net Merit Dollars. From these top Net Merit bulls, you may do some additional screening for type.

2. There is not nearly as much difference in average type between daughters of different A.I. bulls as what is generally believed. Most, if not all, A.I. bulls available are acceptable for functional type traits. Avoid eliminating a high Net Merit bull from your breeding program just because he is "minus" for one or two type traits.

Table 1. Summary of Breeds in the United States

	Number of Animals Registered/Identified Per Year			Trait means for cows born in 2017 (Mature equivalent)					
	1993	2019	Change	Milk	Fat	Protein	PL	SCS	DPR
Ayrshire	6,358	3,145	-51%	19,073	775	614	26.1	2.63	27.5
Brown Swiss	11,334	8,932	-21%	23,554	961	794	25.4	2.53	25.2
Guernsey	9,163	3,407	-63%	17,465	806	586	25.3	2.95	24.5
Holstein	353,849	693,266	+96%	28,253	1,106	888	28.3	2.32	33.0
Jersey	48,606	132,318	+172%	20,934	1,013	773	28.9	2.79	36.4
Milking Shorthorn	2,255	2,252	-0%	19,488	747	604	26.5	2.77	28.3

Table 1 illustrates that Holsteins are the most popular dairy breed in the U.S. with the highest milk production. Jerseys have shown the largest percentage increase in registrations over the past 25 years and have the highest daughter pregnancy rate.

Dairy Cattle Genomic Selection

The cattle genome consisting of 3 billion nucleotide bases (A, T, C, or G) on the 30 chromosome pairs was sequenced in 2004.

By 2007, the Illumina Bovine SNP50 BeadChip was developed that could simultaneously test for 50,000 single nucleotide polymorphism (SNP) markers (A, T, C, or G) at a cost of about $250 per animal. Chips with 777,962 SNP and 6,909 SNP were developed and costs have come down. By 2009, the USDA was able to combine the SNP results with the traditional genetic evaluations to more accurately estimate an animal's genetic value and the modern era of genomic evaluations begin.

As of April 2015, using SNP technology, genotypes were known for 764,029 Holsteins, 99,212 Jerseys, and 18,805 Brown Swiss in North America. By 2018, over 3 million animals had been genotyped. Genomic evaluations has increased the genetic progress of all breeds, but has helped Holsteins and Jerseys more because of the increased testing in the larger breeds. The reliability of the genomic genetic evaluations is 71% for PTA net merit compared to a reliability of about 34% from the animal's parent average alone. Because of the increased accuracy that genomic testing brings to the Holstein breed, genetic progress has increased by over to 50% per year. The use of young sires prior to getting a progeny proof has greatly increased.

Future of dairy cattle genomics:

1. Accuracy of genomic predictions will increase as more animals are tested, computer prediction programs continue to be refined, and more information is shared between countries.

2. Several companies are now marketing marker panels that range from 2,900 to 777,962 markers. In addition to the SNP markers, many of these panels identify individual genes for production traits as well as hair color, polled and genetic defects.

Crossbreeding in Dairy Cattle:

When two breeds are crossed, the resulting crossbred offspring usually exhibits some degree of heterosis. The amount of heterosis in the average of the crossbred's performance minus the average performance of the purebred parents. From past studies, the positive heterosis for milk production has been estimated at around 6%. Heterosis for fertility, health, and longevity would be expected to be higher.

Traditionally, crossbreeding for dairy cattle has not been very popular compared to the amount of crossbreeding in the beef, swine and broiler industries. Research from the 1960s showed that even with heterosis, pure Holsteins still produced more pounds of milk than crossbreds.

For several reasons, the amount of crossbreeding has increased in the dairy industry over the past years:

1. There has been a shift in milk pricing to pay more for pounds of protein and pounds of fat in the milk, and less for volume of milk. This lessens the advantage for Holsteins, which have a lower percent fat and protein in their milk compared to other breeds.

2. The average days open for Holsteins increased by 30 days from 1960 to 2005. Daughter Pregnancy Rate was added to the Net Merit Index in 2003, which is helping to reverse this downward trend in fertility. In the meantime, dairy producers have found that crossbreeding is a much faster way to improve fertility.

3. As dairy herds become larger, there is less time for individual cow care. The average herd size in Minnesota in 2019 was 166 cows per herd. Because of their increased vigor, crossbreds require less pampering than purebreds.

4. A study to compare Holsteins with Holsteins crossed with Viking Reds and Montbeliardes was conducted in seven large Minnesota herds by University of Minnesota researchers. Table 2 show a comparison of these breeds crossed on Holsteins for a few selected traits. On average, the Holsteins produced more lb. of milk, but the crossbreds produced similar fat plus protein lb. and far were superior for fertility and longevity in the herds. Taking all traits into account, the crossbreds had a huge advantage in lifetime profit.

Crossbreeding in dairy herds has been increasing in the United States over the last twenty years. Crossbreds make up about 10% of the dairy cow population in 2020.

Crossbred dairy cows tend to be aggressive eaters.

Table 2. Average Production of the Three First Lactations of Holstein-Montbeliarde-Viking Red Crossbreds and Holsteins in seven large Minnesota Dairy Herds

	Holstein	Two breed crosses	Three breed crosses
Health Treatment costs / lactation	$73	$57	$56
Milk (lbs)	28,400	27,727	25,900
Fat + Protein (lbs)	1995	2018	1921
% of Holsteins for combine fat plus protein	--	101%	96%
Stillbirth rate	5%	3%	4%
Average days open	136	123	118
% that survived 4th calving	28%	38%	48%

SOURCE: Adapted from Hazel, Amy, 2019, PhD Dissertation, University of Minnesota.

Reproduction

How Calves are Conceived and Developed

An animal's birth is the end of a wondrous process called reproduction. It starts when two tiny cells called gametes—an egg, or ovum, from the female and a sperm from the male—join to conceive a new animal. The egg and sperm are sex cells that carry genetic material that determines how the animal will look. The reproductive organs of the male and female produce these cells. Knowing their structure and function is necessary to understand the reproductive process.

Female Reproductive Organs
The dual function of the female is to (1) produce sex cells, or eggs, and (2) furnish a place in her body for the unborn animal to develop. The main female reproductive organs are two ovaries and two oviducts, the uterus, the cervix, the vagina and the vulva (Figure 1).

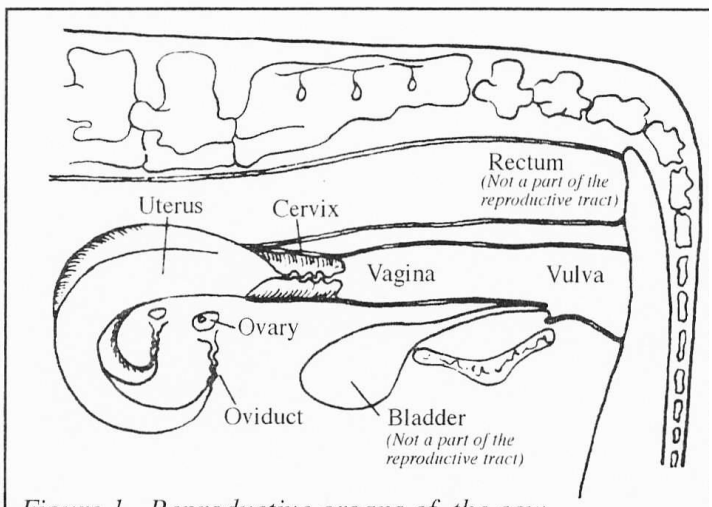


Figure 1. Reproductive organs of the cow.

Ovaries are almond shaped structures 1-1.5 inches long. Eggs are produced by the ovaries. A microscope is needed to see a cow's egg. It is so small that an ordinary thimble would hold two million eggs. There are thousands of eggs present in the ovaries of a female calf at birth. When the female becomes sexually mature (puberty), the ovaries release one egg at regular intervals from blister-like bubbles called follicles.

The oviducts are tube structures that carry the egg to the uterus where the fetus (unborn young) will develop if the egg is fertilized. The end of the oviduct nearest to the ovary is funnel shaped and called the infundibulum. The infundibulum captures the ovum as it is released from the follicle.

The uterus is thick-walled with heavy layers of muscle, but the lining is soft and spongy with a network of blood vessels. This lining provides a bed for the fertilized egg. The uterus has two distinct horns and is attached to the pelvis by the broad ligament. The uterus provides protection and nourishment to the developing fetus. It also aids in the transport of sperm to the oviduct.

A thick-walled fibrous tube called the cervix serves as a gateway between the uterus and the vagina. The cervix typically has 3-4 rings that helps restrict access to the uterus. The cervix protects the uterus and developing fetus from the outside environment during pregnancy.

The vagina connects the cervix with the vulva. The new animal passes through this birth canal when it is born. The vulva and vagina also serve to receive the penis of the male at the time of mating during natural service.

An opening from the bladder is only a few inches from the outside of the vulva. Urine from the bladder passes through this opening.

Male Reproductive Organs
The male organs are the testis, the vas deferens, the accessory glands (seminal vesicles, prostate and cowpers glands), the urethra, and the penis. Urine from the bladder passes through the urethra and penis (Figure 2).

The main function of the male organs is to produce sex cells called sperm, which are needed to fertilize the eggs of the female. In natural mating, the male also must deposit the sperm in the female reproductive tract.

Sperm are produced constantly in tiny tubes inside the testis after the male becomes sexually mature. Sperm produced in each testicle collect in a coiled tube (epididymis) that serves as a storehouse where millions of sperm mature. It takes 45-50 days for sperm to completely develop and become capable of fertilizing an ovum. These structures are held in the scrotum outside the body because they must be kept cooler than body temperature to function properly.

Testicles also produce chemical compounds called hormones that are released into the blood stream. The main hormone, testosterone, is necessary for normal sperm production and causes the development of male characteristics as animals mature. The larger size, heavy neck and shoulders, and deeper voice of the bull are caused by this hormone. Testosterone is also responsible for the aggressive behavior of bulls.

At the time of mating the retractor muscle in the male relaxes, permitting the penis to be extended to deposit 3-5 cc's of semen in the female's vagina next to the cervix. In the male, sperm are moved by muscular contractions from the epididymis through a tube, the vas deferens, into the urethra where the accessory glands add fluids to the sperm at the time of ejaculation. These fluids protect the sperm and help move most of it to the end of the penis. The combined fluid and sperm is called semen.

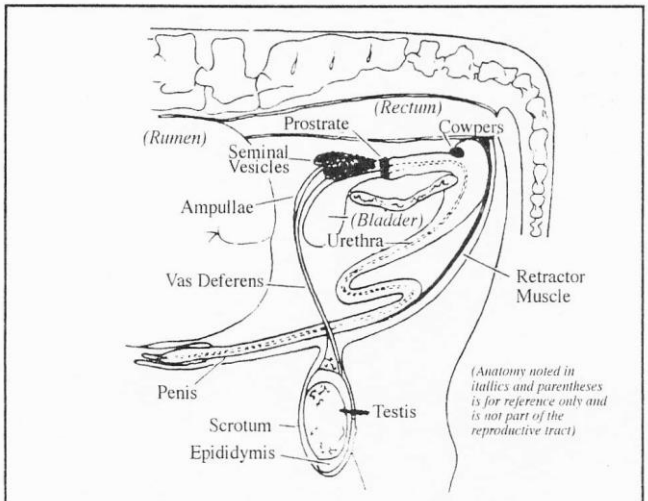


Figure 2. Reproductive organs of the bull.

Fertilization
A follicle on one ovary grows until it bursts, and an egg is released. The release of the egg is called ovulation. The egg is drawn into the funnel shaped membrane called the infundibulum at the end of the oviduct near the ovary. This membrane guides the egg into the oviduct. Here a sperm and the ovum unite forming a new cell (zygote) containing the genetic material from the sperm and the ovum.

Only one sperm cell is needed to fertilize an egg. Millions of sperm are deposited to be sure that one reaches the egg. Muscles in the female's uterus contract and relax to move the sperm through the cervix and uterus into the oviducts. Before the sperm can fertilize the egg, they must undergo a change in their chemistry, known as capacitation.

As it develops, the embryo moves down the oviduct and into the uterus where it becomes attached to the soft, spongy lining. There the embryo will grow and develop along with its membranes until the animal is born.

Meanwhile, other changes are taking place. A structure called the corpus luteum forms where the follicle ruptured. It produces the hormone progesterone. This hormone keeps the uterus in condition for the developing fetus.

If the egg is not fertilized, the corpus luteum will disappear in about 17 days. The female will then be able to produce another egg and show estrus. This cycle repeats itself about every 21 days in a cow until the animal becomes pregnant.

Pregnancy
After fertilization the zygote begins to divide. It continues to double the number of cells. On the first division it becomes a two cell embryo, then 4 cells and keeps dividing, always doubling the number of cells. A network of membranes and blood vessels (placenta) begins to form shortly after the embryo is located in the uterus. The fetus grows and develops inside a fluid filled sack called the amnion. The amnion protects the developing embryo. There is also another outer fluid filled sack called the chorioallantois. Beginning at about 28 days after fertilization the chorioallantois begins to attach to the uterine wall. A velcro like attachment forms to exchange oxygen, nutrients and waste products between the developing fetus and the mother. These attachments are called placentomes and form between the caruncles on the uterus and cotyledons on the placenta. Linking the embryo to the placenta is the navel cord, which connects to the abdomen of the fetus. One blood vessel carries nutrients and oxygen to the embryo, and the other carries waste chemicals back to the placenta. No blood is actually exchanged between the developing embryo and its mother.

About 16 days after fertilization the embryo begins to develop into different tissues. The head, nervous system, and blood system develop first. The bones and limbs are formed later. All organs in the calf are formed by day 45, at which time the embryo is known as a fetus. At 45 days, the fetus appears as a miniature calf and only weighs a few grams. By the end of six months, a Holstein fetus will weigh about 9 pounds and increases to about 95 pounds by nine months.

Birth
The time from conception to birth is called the gestation. The average gestation length for dairy cows is 280 days and varies from 276 to 292. Brown Swiss has the longest average gestation length of 290 days. Bulls are typically carried a couple of days longer than heifer calves and twins are carried 4-5 days less than single calves. A few weeks before calving the ovaries begin to release the hormone relaxin. Relaxin begins relaxation of the cervix and other tissues. Signals from the calf cause a rapid increase in the hormones estrogen, prostaglandins and oxytocin. These hormones work together to cause uterine contractions leading to the birth of the calf.

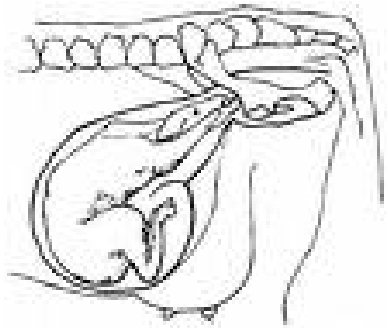


Figure 3. Normal position of the calf before delivery

Until this moment the young animal has received its oxygen and nutrients from its mother's blood stream. The navel cord is broken at birth. This stimulates the calf to breathe and get its own oxygen.

The calf adjusts to its new environment very quickly. However, it depends on its owner to provide a clean, dry and comfortable place to be born and to live and grow.

Managing Reproduction

Reproduction Terms:
- Calving interval – months from one calving to another calving
- Days open – days from calving until conception

- Days to first service – days from calving to first breeding date
- Voluntary waiting period – time after calving when you choose not to breed a cow
- Gestation period – the time from conception until birth

Artificial Insemination
Artificial insemination (AI) of cattle received a major boost in the 1950s when scientists discovered how to freeze sperm from bulls so when it was thawed and placed into the cow it could still fertilize eggs. Semen is collected from the bull with an artificial vagina, checked for quality, extended, placed in small containers called straws, and frozen in liquid nitrogen. Frozen semen is transported in specially made, refrigerated storage containers. The semen is thawed and put into the cow's uterus with an insemination "gun" so it can fertilize the egg.

There are several advantages of using AI instead of a herd bull. Using AI eliminates the danger of dairy farm workers getting injured or killed by herd bulls. AI allows dairy producers to select the best bulls to be sires of their future herd. The risk of spreading reproductive diseases is less. By using sires that throw smaller calves, farmers will have fewer calving problems in first calf heifers. About 60 percent of the dairy calves born in America are from AI.

Estrus Cycles
Estrus cycles are controlled by chemical messengers called hormones. These hormones control behavior, ovulation and maintenance of the pregnancy (Table 1).

Hormone	Source	Estrus Cycle Function
Estrogen	Follicle	Causes signs of estrus, dilates the cervix
Progesterone	Corpus Luteum	Inhibits ovulation and maintains pregnancy
Follicle Stimulating Hormone (FSH)	Pituitary Gland	Stimulates follicles to grow
Luteinizing Hormone (LH)	Pituitary Gland	Ovulation of follicle
Gonatotopin Releasing Hormone (GnRH)	Hypothalamus	Signals pituitary to secrete FSH and LH
Prostaglandins	Uterus	Causes regression (destruction) of the corpus luteum

Table 1. Hormones that Regulate the Bovine Estrus Cycle

Estrus
Estrus, or heat, is the physical evidence that a cow or heifer is sexually active and is ready to be bred. The follicle on the ovary produces a hormone called estrogen that causes the unique behavior associated with estrus. The estrous cycle (number of days from one heat period to the next) averages 21 days. It is usually consistent for an individual animal, but can range from 18 to 24 days and still be normal.

Signs of Heat
Signs that a cow or heifer is coming into heat include restlessness, increased activity, bellowing, following and smelling other animals, attempting to mount other animals, the vulva becoming moist red and slightly swollen, and clear mucus appearing on the vulva or smeared on the tail and buttocks. A cow or heifer is not actually in standing heat until she will stand to be mounted. The other signs are indications she is near standing heat.

Detecting Heat
Successful use of artificial insemination and proper timing of breeding require the dairy producer to efficiently and accurately detect cows in heat. The hardest part of a successful AI program is heat detection. Several techniques are listed below that can help achieve high heat detection efficiency and accuracy.

1. Keep a record of all heat periods, whether the animal is bred or not. This alerts you to the time you expect her to return to heat. Specially designed calendars are available and very helpful.
2. Watch cows housed in freestalls or open sheds when they are not concerned with eating, milking, or other special activities. Move quietly among the cows. Check cows in the morning, afternoon, and late in the evening.
3. Cows in stall barns should be turned out at least twice a day and observed for heat. When cows are lying check for mucus, abnormal discharge or bloody discharge. A bloody discharge indicates the cow was in estrus 2-3 days earlier.
4. Cows express stronger signs of heat on dirt than on concrete. Allowing cows on dirt lots or pasture will increase your success of catching them in heat.
5. Cows in heat interact much more with other cows in heat. When possible, keep open cows in the same group. Also, synchronizing estrus will bring several animals into heat at the same time and make heat detection easier.
6. Heat detector aids – Rump patches that change color when cows are ridden or colored paint that is rubbed off can help identify cows that show estrus when no one was watching. These aids are not a substitute for good management and frequent observation. Electronic systems are also available that measures a cow's change in activity. Cows in heat spend more time walking and interacting with other cows. Sensors mounted on the ear or neck collar measure the increase in activity and computers are used to develop a list of cows with increased activity that are in heat.

When To Breed
It usually takes 30 to 50 days after calving for a cow's reproductive tract to return to a normal, healthy condition. Dairy farmers typically start to breed cows 50 to 90 days after calving. Healthy cows that did not have any problems during calving can be expected to have at least one heat period by 50 days after calving. If the first heat does not occur by this time, a veterinarian should examine the cow.

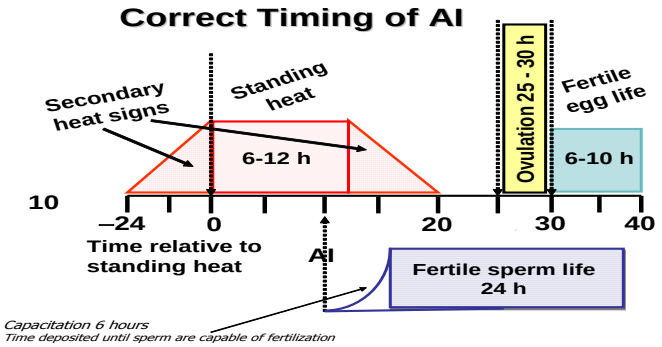
Dairy farmers should know and use the following facts to get the best results in their breeding program:

1. The length of standing heat is variable, but averages 6 to 12 hours with a range of 5 to 30 hours. Wisconsin research has shown that high producing cows have shorter estrus periods than low producing cows and heifers have longer estrus periods than cows.
2. Ovulation (release of the egg) does not occur until 25-30 hours after the start of standing heat.
3. The egg has a fertile life of 6 to 10 hours after it is released from the ovary.
4. Sperm live about 24-30 hours after they are deposited in the cow's reproductive tract. During the first six hours, they undergo a change called capacitation. Capacitation is necessary for sperm to be able to fertilize the egg.

The goal is to time insemination so there are many live capacitated sperm cells in the oviducts at the time of ovulation. It is best if cows are bred toward the end of standing heat. The time-tested rule for when to breed is the a.m.-p.m. rule:

- A cow observed in standing heat in the morning (an a.m. cow) should be bred in the afternoon of the same day.
- A cow observed in standing heat in the afternoon or evening (a p.m. cow) should be bred the following morning.

It is not always practical to follow the a.m.-p.m. rule. Research shows that herds achieve near equal fertility when cows are inseminated only one time each day. With once a day breeding, cows should be bred at the next scheduled breeding after being observed in heat.



Estrus Synchronization Programs
Currently many producers are using timed AI or estrus synchronization programs. The reasons for using synchronization programs include difficulties in visual heat detection, larger herds confined to slippery concrete, and cows housed in tie stall barns not being allowed outside. Also, heat detection and insemination can be done on only a couple of days each week. Some herds use all timed AI and do not watch for heat at all. There are several different programs proven to be effective. All estrus synchronization programs use hormone injections that control the estrous cycle causing cows to ovulate at a certain time. The hormones used in different programs include gonadotropin releasing hormone, prostaglandins and progesterone. For estrus synchronizations programs to be successful, the correct shots must be given to the correct cows at the correct time.

Nutrition
Nutritional deficiencies are not usually the primary cause of poor reproductive performance in a herd that is being fed a balanced ration for high milk production. For reproductive success, recommended amounts of the minerals calcium, phosphorus, and the trace minerals iodine, cobalt, copper, selenium, manganese and zinc should be fed. Also, it is necessary to feed adequate amounts of the vitamins A, D and E.

The most common nutritional cause of reproduction problems is negative energy balance. Cows that are overly fat at calving have lower dry matter intake after calving. These cows have a rapid loss of body weight, are prone to ketosis and other metabolic disorders. Cows that lose too much weight after calving or cows that are losing weight at the time of breeding have delayed first estrus and are less likely to conceive when bred.

The essential fatty acids omega-3 (linolenic) and omega-6 (linoleic) are essential for the cow to make prostaglandins and progesterone. Most normal diets contain adequate amounts of these fatty acids but some research shows that feeding these fats will improve reproductive performance.

Under certain growing conditions some molds can produce poisons called mycotoxins. Some of these mycotoxins contain estrogen like compounds that may interfere with reproduction. Another feedstuff, cottonseed, may contain a toxic compound called gossypol. In high levels gossypol will cause infertility in males and decreased conception rates and increased fetal loss in females.

Measuring and Maximizing Reproductive Efficiency

Cows in herds that are healthy, well-fed, and well-managed have the best reproductive performance. A good manager watches for signs of heat, breeds at the proper time, and keeps accurate records. Most producers plan their breeding program so that each cow will have a calf every 12 to 15 months.

Factors affecting reproductive performance include:

- Voluntary waiting period
- Estrus (heat) detection
- Conception rate
- Reproductive culling

Evaluating Reproductive Performance
Analyzing the success of your reproductive program is required to determine success. The three factors that should be regularly monitored are heat detection rate (sometimes called AI submission rate), conception rate and pregnancy rate.

Let's use an example: Ten cows are open and eligible to be bred in the last 21 days. Twenty-one days are used because this is the average length of an estrus cycle. Five of the cows were detected in heat and inseminated, and two of these became pregnant.

Heat detection rate is defined as the percent of animals observed in heat or inseminated that are eligible to be inseminated. The heat detection rate in this example is 50%. (5 cows bred divided by the 10 cows eligible to be bred = 50%) This is the biggest factor that determines how many cows get pregnant in most herds. The heat detection rate of cows in Minnesota DHIA herds averages about 30%. Many herds have implemented estrus synchronization to dramatically increase the heat detection rate on first service.

Conception rate measures the percentage of animals that become pregnant when they are bred. The conception rate in this example is 40%. (2 cows conceived divided by the 5 cows that were bred = 40%). Normal conception rates for cows are 30 to 45 percent. Heifer conception rates are higher than cows averaging about 65%. Conception also is measured by services per conception. Services per conception and conception rate are mathematical reciprocals (1 divided by 50 percent conception rate = 2.0 services per conception). Factors affecting conception rate include:

- Heat detection accuracy
- Cow fertility
- Semen (bull) fertility
- AI technique

Pregnancy rate is the percent of cows becoming pregnant that are eligible to become pregnant. The pregnancy rate in the example is 20% (2 cows conceived divided by 10 cows eligible to become pregnant). An alternative method of calculating pregnancy rate is heat detection rate times conception rate (.50 x .40 = 20%). This is the best measure of reproductive performance of a dairy herd. The average pregnancy rate of Minnesota DHIA herds is 13-14%.

Attention to details determines the success or failure of reproductive programs. The following management practices are necessary to maintain breeding efficiency:

1. Keep accurate records of calving dates, heat periods, breeding dates, and any calving problems.
2. If reproduction performance is poor, consider an estrus synchronization program. This will make heat detection and breeding easier.
3. Use artificial insemination to reduce the spread of most reproductive diseases.
4. Provide a high quality ration and a clean, dry place for each cow at calving time to minimize the risk of disease at calving.

Use your veterinarian to help maintain breeding efficiency. The veterinarian should:

1. Regularly schedule herd health exams. Pregnancy examine cows that have been bred 30 days ago. Also examine cows that have not shown signs of heat by 50 days after calving and cows that aren't pregnant after 3 to 4 services.
2. Check animals that aborted, had a difficult calving, or show abnormal discharges before you breed them.
3. Set up a program to control all disease problems in the herd, including a vaccination program to prevent diseases affecting reproduction.
4. Isolate purchased animals until your veterinarian is sure they are free of disease.

Reproductive Problems

Cows experiencing problems around the time of calving such as dystocia (calving difficulty), twins, retained placenta and metritis (uterine inflammation) usually have more reproductive problems. Proper care of cows during the dry period, at calving, and after calving will increase the likelihood that they will be healthier and have less reproductive problems. There is little doubt, however, that the most frequent reason for breeding failure is faulty heat detection and improper timing of service. This is especially true in herds bred by artificial insemination.

A summary of many of the factors that affect reproductive efficiency in dairy cattle is presented in this section to help you recognize problems that may be present in your herd.

Physiological Factors

Age is one factor that affects reproduction. Heifers are more fertile than cows. Cows are less fertile because they have added stress from milk production and possible reproductive problems such as retained placenta and metritis. An imbalance in hormone production due to cystic ovaries can result in abnormal heat cycle length, lack of heat periods, or a cow in constant heat. Get the help of a veterinarian to diagnose and correct these problems.

Seasonal Effects and Heat Stress

Dairy cattle are most fertile in the spring and fall and least fertile in the summer. Most of this is related to the effect of heat and humidity. Some possible reasons is that cows eat less and this may affect hormone levels. Another reason is that the high body temperature may impact the fertile embryo, resulting in early abortion or lack of implantation.

Twinning and Freemartin

About five percent of all dairy cattle births result in twins. The biggest factor that influence whether a cow has twins is milk production. Higher producing cows are more likely to have twins. Season also has an influence with cows calving from April to June having the most twins and cows calving from October through December having the fewest twins. Older cows are more likely to have twins than young cows or heifers. Cows that have twins have more complications at calving and are harder to get rebred. The calves are also more likely to be stillborn or weak at birth.

A twin heifer whose twin is a bull has a 90 percent chance of being a freemartin. Her reproductive organs do not develop normally, and she is infertile. A veterinarian can confirm this by examination, but nothing can be done to correct the

situation. Genetic tests are available to determine if the heifer calf is a freemartin.

Inherited Abnormalities
Inherited abnormalities that affect the reproductive tract are rarely found in dairy cattle. A recessive genetic condition in which the reproductive tract fails to develop, normally known as "white heifer disease," is reported to occur in Milking Shorthorn, but the incidence of occurrence is very low.

Diseases
Several diseases can affect reproduction by causing infertility and/or abortion. Consult a veterinarian when you suspect disease problems, and follow his/her advice about disease vaccination programs.

- Brucellosis – causes abortion at 5 to 9 months of the gestation period. A blood test is needed to identify infected individuals so they can be removed from the herd.
- Campylobacteriosis (vibriosis) – short, irregular heat cycles and abortion at 4 to 6 months are the main symptoms. It is spread by an infected bull, and treatment by a veterinarian may be possible. Use semen from reputable bull stud and breed cows by artificial insemination to prevent disease.
- Trichomoniasis – loss of fetus at 1 to 16 weeks, and short, irregular heat cycles are the major symptoms. Complete records of heat periods are important to help identify this problem. It is spread by an infected bull, and use of AI is a good preventive measure.
- Leptospirosis – causes abortion after 5 months. A blood or urine test is needed to identify this disease.
- IBR (infectious bovine rhinotracheitus) – a viral infection that also is called red nose. Abortion occurs during the last three months of pregnancy.
- BVD (Bovine viral diarrhea) – may result in increased early embryonic death or abortions Most abortions occur during the first two-thirds of pregnancy. A blood or ear notch sample can be used to test for the disease.

Uterine Infections
Uterine infections (metritis) are caused by a variety of bacterial organisms, fungus or molds. An abnormal discharge following calving may be due to an infection within the uterus. Provide a clean, dry place for the cow to calve to help prevent this problem. Your veterinarian can treat these infections.

The placenta (afterbirth) is normally expelled a few hours after calving. It is considered a retained placenta if the placenta is not expelled within 24 hours after calving. Manual removal of a retained placenta may cause more problems than it solves. Infectious organisms can be introduced into the uterus if an attempt is made to remove it without using sanitary procedures. Consult with your veterinarian and establish a management and treatment plan for cows with retained placenta.

When to Breed Heifers
Size is a better measure than age alone for determining when heifers should be bred. There is a difference in growth rates among individuals as well as among breeds.

Adequately fed heifers can be bred when they are 13 to 15 months old. Since the gestation period is about 9 months, they will calve when they are 22 to 24 months of age. This should be your goal. Monitor growth of heifers by measuring weight and stature.

A heifer that is bred too early may be undersized when she is mature. This is because her growth rate tends to slow when she starts producing milk. Therefore, it may be necessary to delay breeding a heifer that is small for her age until she reaches the proper size.

Reproduction Technologies

Embryo Transfer
Embryo transfer allows someone to obtain many more offspring from genetically superior cows than is possible otherwise. Embryo transfer is when a donor cow is injected with a follicle stimulating hormone (FSH) to cause her to ovulate several ovum. Gonadotropin releasing hormone (GnRH) and prostaglandins are also used in superovulation. Six to eight days after insemination the embryos are flushed from the donor cow's uterus by a non-surgical technique. This results in several fertilized embryos that can be transferred to recipients or frozen in liquid nitrogen to be thawed and placed in a recipient later. The embryos are evaluated and transferred into recipient females who give birth to the calf.

Cloning
The technology of making exact copies of the same embryo is called cloning (also known as nuclear transfer). The two methods of cloning an embryo are embryo-splitting or nuclear transfer cloning.

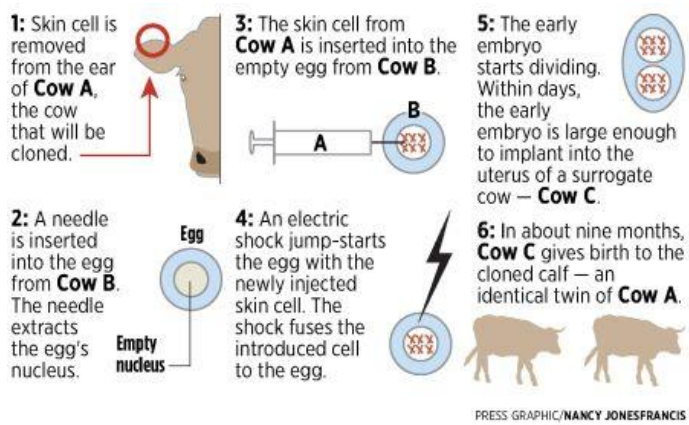


Figure 4. Process of nuclear transfer cloning

Nuclear transfer cloning – In this process, the nucleus of a normal body cell is removed and inserted into an unfertilized egg that has had its nucleus removed. The egg with its donated nucleus is then nurtured and divides until it becomes an embryo. The embryo is then transferred into a recipient female which gives birth to the calf.

Embryo-split cloning – The young fertilized embryo starts as one cell then divides into two cells, then four cells and keeps doubling. At this early stage of development, the nucleus of each cell contains all of the genetic information required for that individual cell to become a calf. These cells can be split apart in the laboratory and each cell will begin to form its own embryo, each genetically identical. This is how identical twins develop naturally, except with cloning it is done in a laboratory.

In Vitro Fertilization

In vitro fertilization, abbreviated IVF, is a technique where sperm fertilize an ovum in a laboratory dish or test tube. The fertilized ovum grows into a young embryo in the laboratory and then is transferred to a recipient female.

Gender Selection

The ability to sort semen for gender was developed in the late 1980's, and the technology has been gradually improving since then.

The semen is stained with a fluorescent dye and sent through a machine that uses a laser to evaluate each sperm cell. Because the X-chromosome is 3-4% larger than the Y-chromosome, it emits more light from the dye. Based on this difference, the sperm split into three different groups: X chromosome containing sperm (female), Y chromosome containing sperm (male) and a discard group that the technology cannot distinguish.

There are some challenges with producing sexed semen. The process is very slow and much of the sperm must be discarded because it is male sperm or the machine cannot distinguish the sperm. Because of the waste, the sperm numbers packaged per straw are lower. This means that the cost for gender selected semen is higher. Conception rates are also about 25% lower than with conventional semen. Herds that normally run 60-65% conception in virgin heifers should expect a conception rate of 45-50% with sexed semen. It is recommended that sexed semen only be used in heifers in excellent standing heat.

One advantage is that the chance of a heifer having a heifer calf increases from about 50% to about 90%. Also heifer calves are usually easier to deliver than bulls, so calving ease is another benefit.

Nutrition and Feeding

Dairy cattle are ruminant animals. A major advantage of ruminants is their ability to convert feeds not usable by humans, such as forages and certain by-products, into human foods. This conversion process results from feeds being digested by microorganisms in the rumen stomach and being absorbed by the digestive tract to be used in producing milk and meat. The dairy cow's digestive tract includes the mouth, esophagus, four-compartment stomach, small intestine and large intestine (figure 1).

Ruminant Digestive System

The rumen is the largest of the four compartments and holds up to 25 gallons of material in mature cows. Bacteria and protozoa break down (digest) the fibrous forage and convert it to useful nutrients. The rumen serves as a huge fermentation vat that is constantly churning and moving. Cows spend 35 to 40 percent of each day ruminating (chewing their cud). Long particles are regurgitated for re-chewing to reduce size and add saliva. Since gases (methane and carbon dioxide) are given off, bloating can occur if the gas is not belched up (eructation). No oxygen (anaerobic) is present in the rumen mixture and it is near neutral in acidity (pH 6.2 to 6.8).

The reticulum consists of a network arrangement of tissue. It holds back large particles of feed so the bacteria can digest them further. Hardware (nails, wire, etc.) will get caught in this area. Since the reticulum lies close to the heart, these sharp objects may work into the heart and cause death. This is called hardware disease. Dairy farmers often place magnets in this part of the stomach to hold metal and avoid damage.

The omasum contains many leaf-like tissues similar to pages in a book. It removes water and other substances from the digested contents, so the feed material is drier than that found in other stomach compartments.

The abomasum (true stomach) functions like the stomach of a non-ruminant or human. Enzymes that digest and break down feed are secreted. Hydrochloric acid is also produced, making the digesting feed quite acid. In a twisted stomach (displaced abomasum), the abomasum moves to an abnormal position and cuts off the flow of feed.

The small intestine is composed of three sections: the duodenum, jejunum, and ileum. The small intestine receives the secretions of the pancreas and the gallbladder, which aid indigestion. Most of the digestive process takes place here, and many nutrients are absorbed through the villi (small finger-like projections) into the blood and lymphatic systems.

The large intestine is the last segment of the tract through which undigested feedstuffs pass. Some bacterial digestion of undigested feed occurs, but absorption of water is the primary digestive activity occurring in the large intestine.

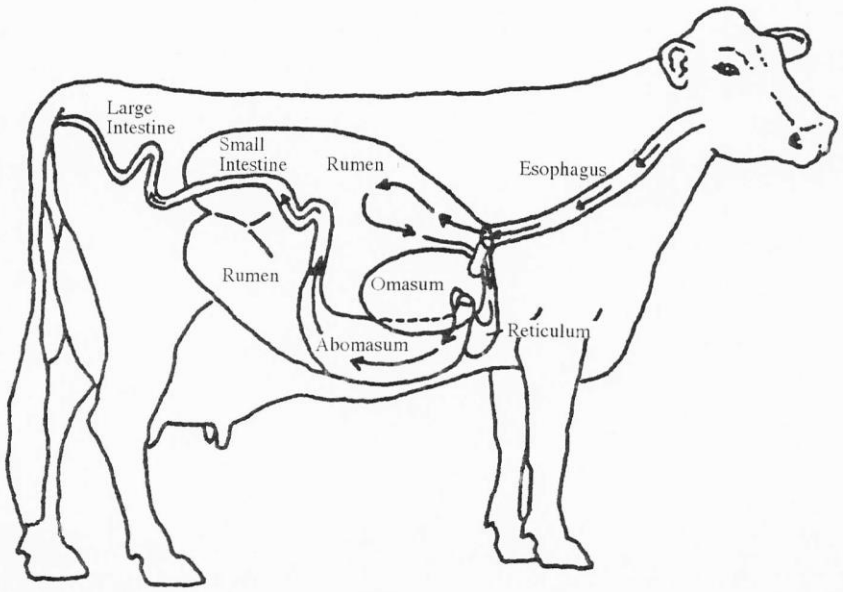


Figure 1. Anatomy of the adult dairy animal's digestive tract.

Digestion in the Rumen

Many complicated reactions occur in the rumen. The rumen microbes convert feed to products the animal can use directly. The microbes also grow and multiply, and the ruminant animal digests them in the small intestine as microbial protein.

Proteins are partially broken down to ammonia, organic acids, amino acids and other products. Many rumen microorganisms require ammonia (a breakdown product of protein) for growth and formation of microbial protein. Ammonia also may be provided from NPN (non-protein nitrogen) sources such as urea, ammonium salts, nitrates, and other compounds. Rumen microbes convert the ammonia and organic acids into amino acids that are assembled into microbial protein. Most excess ammonia is absorbed from the rumen into the blood stream, but small amounts may pass into the lower digestive tract and be absorbed. Feed protein that escapes breakdown in the rumen (by-pass or undegraded protein) and microbial protein pass to the abomasum and small intestine for digestion and absorption.

Carbohydrates (sugar, starches, and fiber) are converted to volatile fatty acids (acetic, propionic, and butyric). The cow absorbs these acids and uses them as the primary energy source for body functions like growth and milk production.

Fats are changed from triglycerides to glycerol and free fatty acids and vegetable oils may have hydrogens added to them by the rumen microbes.

Vitamin K and the B vitamins are manufactured by the rumen microorganisms in sufficient quantity for normal growth and maintenance. Under most conditions, cattle with functioning rumens do not require supplemental B vitamins or vitamin K in the diet. Niacin (B3) and thiamine (B1) may be needed under stress conditions.

Digestion in The Calf Stomach

In a newborn calf, the rumen and reticulum are not developed. The calf actually digests feed like a nonruminant since the abomasum is the largest stomach compartment. At this stage of life, the rumen is nonfunctional and some feeds digested by the adult cannot be used by the calf. During nursing or feeding from a bucket, milk bypasses the rumen via the esophageal groove (also called reticular groove) and passes directly into the abomasum. The consumption of milk causes a reflex action that closes the groove to form a tubelike structure that prevents milk or milk replacer from entering the rumen. When milk is consumed very rapidly, some may overflow into the rumen.

As long as the calf remains on milk only, the rumen remains undeveloped. When calves begin consuming grain and forage, a microbial population becomes established in the rumen and reticulum. End products of microbial fermentation are responsible for the development of the rumen. This occurs as early as 3 weeks of age with most feeding programs. Cud inoculation is not necessary to initiate rumen development. If grain feeding with or without forage is started during the first few weeks of life, the rumen will become larger and heavier with papillae development and will begin functioning like the adult's when the calf is about three months of age.

Major Feed Nutrients

Feed nutrients are required in proportionate amounts to allow for proper animal growth, milk production and body function. The six major nutrients for dairy cattle include carbohydrates, fats, proteins, vitamins, minerals and water.

Carbohydrates

Carbohydrates are the major energy nutrients. There are many carbohydrates. Even the relatively simple ones are complicated chemical compounds. All carbohydrates are made up of carbon, hydrogen and oxygen. Carbon is the key. There are thousands of possible combinations of carbon, hydrogen and oxygen. Carbohydrates are broken down into three categories: sugars, starch, and fiber.

Sugars and starches are relatively simple. Cellulose is one of the more complex carbohydrates that cattle can use. Sugars and starches are easy to digest. They have a high "feeding value" because a very small percentage pass through the body undigested. Grains such as corn and oats contain sugar and starch.

Cellulose makes up part of the fiber in plants. Grass, for example, has much cellulose. Cellulose is hard to digest. Cellulose has a low feeding value for most animals; however, cattle can digest large amounts of cellulose with the aid of bacteria in the rumen. Adequate fiber levels are required in all diets of dairy cattle to assure proper rumen function in addition to the energy source.

Fats

Another group of energy nutrients include fats and oils. The energy content of fat is about 2.25 times the energy in carbohydrates. Diets for baby calves that include large quantities of milk or milk replacer may contain 10 to 35 percent fat in the DM consumed. Fat may be added to the diets of adult ruminants to increase energy density and to reduce feed dustiness. Typical diets usually contain no more than 4 percent fat in the DM. Total fat and oil should be limited to

less than 7 percent of the DM in lactating cow rations. Too much fat decreases feed intake, may depress fat and protein content of milk, and may cause scouring. Commonly fed sources of fat include whole cottonseeds, full-fat soybeans, sunflower seeds, tallow and various rumen-inert fat products.

Proteins

Protein is essential for maintenance, growth and milk production. Dairy cattle's protein requirement is really a requirement for amino acids by animal tissues. Amino acids are supplied by digesting microbial protein, and by feeding protein that escapes microbial breakdown in the rumen.

Approximately 60 percent of the crude protein (CP) in the typical dairy cow diet is broken down by microbial digestion to ammonia. The rumen microbes must convert the ammonia to microbial protein if the dairy animal is to receive any benefit. If rumen ammonia levels are excessively high, the ammonia is absorbed into the blood and recycled or excreted in urine as urea. All feed protein sources are not degraded in the rumen to the same extent.

Three protein terms describe the fate of dietary protein in the rumen. Rumen degradable protein (RDP) is the portion of feed protein broken down to ammonia or amino acids by the rumen microbes. Soluble protein (SP) is the portion of RDP that is rapidly degraded in the rumen. Generally, SP is about half of the RDP. Rumen undegradable protein (RUP) is the portion of feed protein that is not degraded by the rumen microbes and remains intact as it passes through the rumen to be digested and absorbed further as it moves through the digestive tract. Other terms for RUP include by-pass protein and escape protein. Protein that ultimately is used by the animal is called metabolizable protein (MP).

Vitamins

Vitamins are organic compounds needed in small amounts to support life. They contribute no measurable amount of protein or energy to the animal but function in chemical reactions involving other nutrients. If a vitamin deficiency occurs, definite symptoms appear and become more severe unless corrected.

The vitamins can be classified into two broad groups: 1) water soluble vitamins, and 2) fat soluble vitamins. Vitamins A, D, E and K are fat-soluble vitamins because they dissolve in fat solvents such as ether and chloroform. Vitamins B complex and C are water-soluble vitamins because they dissolve in water.

Vitamin A keeps eye and body cell linings healthy and working. An animal short of vitamin A has night blindness, is weak, has a greater chance of infections and reproductive problems. Carotene is the feed source of vitamin A. Green leafy forages and yellow corn are good sources of carotene. In addition, synthetic vitamin A is usually added to dairy rations.

Vitamin B complex is a group of vitamins that is necessary to change feed into energy. Animals low on B complex vitamins may be paralyzed, lose hair, become sick, have a poor appetite or become run down. Cereal grains (wheat and oats, for example) and rumen bacteria are good sources of B vitamins. Dairy animals are seldom low on B vitamins because they are ruminants. Supplemental B may be needed for stressed or diseased animals and very young calves.

Vitamin C is normally produced by ruminant body tissue. Adding it to the feed is not necessary. Shortage of vitamin C can result in loosening of teeth, brittle bones, slow growth and a sore mouth. Vitamin C also is called ascorbic acid.

Vitamin D is needed for strong bones. Animals low in vitamin D can have weak bones, swollen joints and stiffness. They drag their hind feet and are weak. This condition is called rickets. Green, leafy, sun-cured feed and fish oils are excellent sources of vitamin D. Cattle can make their own vitamin D if they are exposed to direct sunlight. Supplementing vitamin D in the ration is recommended.

Vitamin E is an antioxidant, reducing off-flavors in milk, preventing white muscle disease in calves, lessening the severity and duration of subclinical mastitis, improving reproductive performance and stimulating the immune system. Vitamin E is associated with selenium, and supplementing the ration is recommended.

Minerals

Minerals have both structural and regulatory functions. They are needed for bone and teeth formation, hormone actions, enzyme activation and water balance. They are a structural part of hormones (iodine in thyroxin as an example) and hemoglobin (iron).

The minerals needed in largest amounts (macro minerals) by the dairy cow include calcium, phosphorus, magnesium, sodium, chlorine, sulfur and potassium. Sodium and chlorine usually are provided in the form of salt. Minerals required in small amounts (trace minerals) include iron, copper, manganese, zinc, iodine, cobalt and selenium.

Water

Water is the nutrient required in the largest amount by dairy cattle. This last nutrient on our list is so common that we may forget it. Water is the largest part of nearly all living things Your dairy animal's body is three-fourths water.

Water performs many tasks in the body. It makes up most of the blood that carries nutrients to the cells and carries waste products away. Water is necessary in most of the body's chemical reactions. In addition, water is the body's built-in cooling system. It regulates body heat. It acts as a lubricant. An animal can live longer without food than without water.

Feeding the Dairy Animal

Feeds that are fed to the dairy animal are generally referred to as feedstuffs. Feedstuffs are often classified as forages and concentrates.

Forage consists of the whole plant. Legumes and grasses are a major source of forage for dairy animals. Alfalfa hay and corn silage are two examples. These feeds are bulky, high in fiber (which the cow needs for proper rumen digestion) and are excellent sources of protein, energy, carotene, calcium and other minerals. Forage is usually fed at about 2 percent of a cow's body weight (on a 100 percent dry matter basis).

Important considerations in harvesting high-quality forages are the cutting date and stage of maturity. As the forage plants increase in maturity the feed value decreases. Legumes should be harvested in the bud to first bloom stage, grasses and small grains in the boot stage, and corn silage should be harvested when kernels are fully dented and the milk line is 1/2 to 2/3 down from the crown. Forage evaluation of the nutrient content is necessary to properly balance the total daily nutrient needs of the dairy animal.

Concentrates consist of grains, by-product feeds, protein supplements, minerals, vitamins and feed additives. The major purpose of feeding concentrates is to supply additional nutrients required for growth and production above those obtained from forages.

Grains and by-product feeds are excellent sources of energy. Processing the grain by rolling, crimping, cracking or grinding increases its digestibility when fed to dairy animals. Coarse-textured, processed grain can improve palatability and intake. Because young animals chew their feed more thoroughly than adults, whole grains can be fed up to 12 months of age.

Examples of energy grains include barley, ear corn, shelled corn, oats, rye, sorghum and wheat. Energy by-product feeds include beet pulp, corn gluten feed, whole cottonseed, fats and hominy feed.

Protein supplements are portions of plant seeds that are high in crude protein. Some by-product feeds also are considered excellent protein sources. Protein supplements are needed to meet the high protein needs of lactating dairy cows. A by-pass protein source may be beneficial in early lactation rations for high producing cows.

Examples of protein supplements include whole soybeans and urea. Protein by-product feeds include soybean meal, linseed meal, cottonseed meal, blood meal, brewers grain, corn gluten meal, distillers grain, feather meal and meat and bone meal.

Mineral supplements are feeds that contain key minerals needed by the cow. Di-calcium phosphate and trace mineralized salt are examples. Cows should receive additional calcium, phosphorus, salt, and trace minerals (iodine, cobalt, manganese, zinc, copper and iron). One percent trace-mineralized salt and one percent of a calcium phosphorus supplement in the dry grain mixture (20 lb./ ton of each) is a guide. Topdressing 2 to 4 ounces per cow per day is another method of feeding.

Vitamins are found in feeds or synthetic products. Vitamin D from irradiated yeast and synthetic A are two synthetic products. Dairy cows need vitamins A, D and E, which can be provided by forage and grains, supplemented with a vitamin premix, or injected. The daily need for a cow is 100,000 IU (international units) of vitamin A, 30,000 IU of vitamin D, and 300 to 800 IU of vitamin E.

Feeding the Calf

When the calf is born, it is extremely important to get it started on the right feeding program. The calf is born with no immunity to disease and therefore immediate feeding of high quality colostrum is one of the most important steps to increase survival and health of newborn calves. Quality colostrum contains antibodies. Antibodies are compounds in colostrum milk that protect the calf from disease.

Without colostrum, the calf has little or no protection from scours, respiratory ailments and other diseases. The antibodies are produced in the cow's blood and transferred into the milk. When the newborn calf drinks the milk, the antibodies are absorbed into the calf's small intestine and into the blood stream. The calf s ability to absorb antibodies begins to decrease shortly after birth, so it is important to feed the calf as soon as possible.

Hints to help care for your calf

At birth. Immediately after your calf is born, feed it milk from the calf's mother (colostrum). Feed 4 to 8 pounds (2 to 4 quarts) in a nipple bottle or nipple pail. Be sure the nipple is clean. Use an esophageal feeder if necessary to get colostrum into the calf in the first 6-8 hours.

First days after birth. Feed your calf colostrum or milk for three days. Although colostrum is commonly defined as the secretions from the first 3 days of lactation, true colostrum is obtained only from the first milking. The next couple of days the milk is referred to as transitional milk.

After 3 days. You can switch your calf to whole milk from the herd or to a commercial milk replacer. Feed an amount equal to 8-12 percent of your calf's weight daily. At this time, begin

offering your calf a good quality, tasty 18% calf starter. Hay is not recommended until weaning. Always provide fresh water.

At weaning. Your calf can be weaned when it is 1 to 2 months old. Your calf should be eating 2 or more pounds of calf starter daily. Keep fresh calf starter available to your calf and feed it some high quality hay. Offer fresh feed each day; don't let feed get old and stale. Be sure fresh, clean water is available.

After weaning. Continue to feed your calf good quality calf starter (grain) at the rate of 3 to 5 pounds per day. This mixture should have energy, protein, minerals and vitamins. Give your calf all the good quality hay or hay silage it will eat. Keep plenty of fresh water available at all times.

After 4 months of age. Your calf should be growing well and eating plenty of hay or hay silage. You can put your calf on pasture or feed it limited amounts of corn silage, but also feed it grain to keep it growing properly. The amount and type of grain mix will depend on the forage you are feeding your calf and the calf's condition. Don't let your calf get too fat!

Feed additives can be used in calf feeding programs. Decoquinate, when added to milk replacers and calf starters, can significantly reduce coccidiosis in the first 2 months of growth. All growing heifers should be fed an ionophore (monensin or lasalocid) to improve feed efficiency, control coccidiosis and lower growth costs. Expect daily gain increases of .1 to .2 pounds when ionophores are added to the diet. You can feed ionophores to heifers until calving, but not to milking animals.

Feeding the Growing Heifer

The nutritional requirements of heifers change as they mature. Younger heifers lack the rumen capacity to maintain satisfactory weight gains if they are fed only forage. Older heifers, however, have sufficient rumen capacity for adequate growth if fed only high-quality forage rations. Combining corn silage and alfalfa limits energy intake and provides adequate protein for proper growth of yearlings.

Table 1 shows suggested nutrient specifications and dry matter intake for heifers in four age groups. Total dry matter intake of older heifers, as a percentage of body weight, decreases as forage intake increases. Forage quality determines the amount and protein content of supplemental grain needed. A decrease in forage quality increases the amount of grain that must be fed.

Different grains and supplements can be used in a concentrate mix. A typical mix contains shelled corn, soybean meal or commercial protein supplement, dicalcium phosphate, trace mineralized salt, vitamins and feed additives. Heifers under six months old should receive 3 to 6 pounds of grain per head per day, depending on the amount and quality of forage being fed. Older heifers may need only 2 to 4 pounds of grain daily.

Table 1. Suggested Nutrients Needed for Growing Heifers

Age	**3-6 mos.**	**7-12 mos.**	**13-18 mos.**	**19-22 mos.**
Average weight (lb. large breed heifers)	300	600	900	1100
Estimated dry matter intake. Lbs/day	7--9	12--16	17--21	22--26
Percent of body weight	2.7-3.0	2.7	2.5	2
	Nutrient specifications (% of dry matter)			
Crude protein	16	16	14	14
Total digestible (TDN)	68-74	64-70	60-63	60-63
Calcium	.50-.60	0.40-.50	.40-.50	.40-.50
Phosphorus	.35-.40	.32-.35	.28-.32	.28-.30
Trace mineral salt	0.3	0.3	0.3	0.3
Vitamin A (IU/lb. DM)	1,000	1,000	1,000	1,000
Vitamin D (IU/lb. DM)	140	140	140	140
Vitamin E (IU/lb. DM)	11	11	11	11

Heifers on pasture need to be monitored closely for adequate growth. Pasture usually is abundant and of good quality in the spring. However, the pasture declines rapidly by mid- to late summer.

Intensive rotational grazing of pastures can help improve quality throughout the grazing season, thus requiring less grain supplementation to obtain optimum growth.

It is necessary to monitor heifer growth to determine if your nutrition program is on target. A goal of 1.6 to 1.8 pounds of average daily gain (ADG) is suggested for Holstein and Brown Swiss heifers, with an ADG of 1.4 to 1.6 pounds for Ayrshire, Guernsey, Milking Shorthorn and an ADG of 1.2 to 1.4 pounds for Jerseys. Another important growth measurement is height.

Overfeeding energy and underfeeding protein, especially from birth to puberty, can result in overweight heifers that lack adequate stature. It is important to measure your heifer's growth pattern by using scales or weight tape and an altitude or measuring stick. Table 2 provides a guide for optimum growth objectives of dairy heifers.

Table 2. Heifer Growth Objectives

Age	Holstein and Brown Swiss		Ayrshire and Guernsey		Jersey	
(months)	Weight (lb.)	Height/in.	Weight (lb.)	Height/in.	Weight (lb)	Height/in.
0	94	32	70	27	55	26
6	400	41	320	41	275	39
14	875	50	680	48	575	45
24	1340	54	1150	53	960	51

Feeding the Dairy Cow

Now that the heifer has calved, she is ready to pay for her expenses that accumulated during the first two growing years and make a profit for you. Her profit-making potential will depend on her ability to produce large quantities of milk while maintaining a healthy, reproductive condition for a number of years. The feeding program will have a direct influence on allowing the cow to achieve her profit-making potential.

Nutrition requirements will vary with the stage of lactation and gestation (table 3). There are different feeding phases that help attain optimum production, reproduction and health of the dairy cow.

The early lactation phase requires a high level of nutrients because milk production increases rapidly during this period, peaking at six to eight weeks. The cow's ability to eat enough feed does not keep pace with the nutrient needs for milk production. The cow will lose weight due to her ability to mobilize or use body fat as an energy source for producing milk.

Peak dry matter feed intake will occur approximately 10 weeks after calving. In a well-balanced nutrient-dense diet, cows should be able to eat enough and no longer be losing body weight at 10 to 12 weeks after calving.

Crude protein in the total daily ration should be balanced at 18 to 19 percent (on a dry matter basis) during early lactation. Feeds containing undegraded or by-pass protein should be included in the diet to provide 35 to 40 percent of the crude protein needs.

Energy is the most limiting nutrient for high producing cows. High energy feeds, measured as net energy-lactation (NEL) are needed in the feedstuffs to provide .78 to .80 megacalories (Mcal) per pound of dry matter (DM). The feeding challenge is to provide an energy- dense diet while maintaining adequate fiber for rumen function and good animal health.

A minimum of 18 to 19 percent acid detergent fiber (ADF) in the diet is a goal for the early lactation feeding phase.

Forages should provide a minimum of 21 percent neutral detergent fiber (NDF) in the dietary dry matter intake. After calving, the grain feeding level should be adjusted upward gradually at the rate of 1 pound per day to avoid digestive upsets.

High-quality forages must be a major component of the early lactation diet. A minimum intake of 1.5 pounds of forage DM per 100 pounds of body weight is needed to provide adequate fiber and reduce the chances for acidosis and low milk fat percentage. A preferred goal of 1.8 to 2.0 pounds of forage DM intake per 100 pounds of body weight is attainable when feeding high quality legumes as the major forage source.

Salt, minerals and vitamins must be added to feed to meet the cow's requirements based on how much milk she is producing. Feedstuffs should not be chopped or ground too fine.

Mid- to late lactation is an easier phase to manage nutritionally. Milk production is declining, the cow is pregnant and nutrient intake will easily meet or exceed requirements. The cow should be adding body weight to rebuild her body reserves for the next lactation. It is recommended to replace body condition during late lactation versus the dry period. A

goal of 3.0 to 3.5 body condition score (1 = thin; 5 = fat) is suggested at drying off.

Balancing the diet of cows in mid- to late lactation is equally important as in the early lactation phase. Overfeeding will increase feed cost and reduce profits while increasing the possibility for over conditioned or fat cows. Under- feeding will not allow the cow to produce to her optimum ability and restrict added growth of two-year cows.

Daily crude protein levels can be reduced to 16 percent at mid-lactation and 14 percent in late lactation. Urea, a nonprotein nitrogen (NPN), can be fed as a cheaper protein source with a limit of no more than .4 pounds per cow per day. Energy levels also can be reduced based on production and growth needs. Net-energy lactation values of .74 to .72 Mcal per pound in the daily ration is acceptable.

Forage quality can be lower for this production phase. Therefore, it is highly recommended to manage the forage supplies by feeding the highest quality forage to the early lactation cows. Continue to add adequate amounts of minerals and vitamins based on the cow's requirements.

The dry period is the last and very critical phase of feeding the cow. The dry cow program must be separate from the lactating cow. A required dry period of 45 to 60 days is the goal. Key nutritional points of the dry cow feeding program include maintaining the desired body condition score (BCS) of 3.5 to 4.0; meeting the nutrient requirements and avoiding excessive feeding; avoiding excess calcium and phosphorus intakes; and changing to a dry-cow transition ration starting two weeks before calving.

Feed additives for milking cows have a place in early lactation rations. Additives should be considered on a farm-by-farm basis. Niacin is a B vitamin (B3) that can help prevent ketosis and maintain dry matter intake. Currently, feeding 6 to 12 grams per day until maximum dry matter intake occurs is recommended (10 to 12 weeks after calving).

Buffers are additives that help maintain rumen pH. Sodium bicarbonate and sodium sesquicarbonate are the most common commercial products fed at .3 to .5 pound per cow per day. Magnesium oxide is not a buffer, but is an alkalinizer (it raises pH). A combination of two to three parts buffer to one part magnesium oxide is recommended.

Propylene glycol is converted in the liver to glucose, which can help prevent ketosis and fatty liver formation. Drenching one pound per day to cows with elevated blood ketones (based on milk or urine color tests) has been successfully used in the field.

Yeast cultures and yeast products can stimulate fiber digesting bacteria, maintain rumen pH, and stimulate VFA production. Yeast products also can keep cows on feed and are palatable. The level of yeast cultures and products varies from .025 to .25 pound per cow per day (depending on the concentration of yeast and source).

Table 3. Suggested Nutrients Needed for Cows

	Early Lactation	Mid to Late Lactation	Dry Cows
Crude Protein (%)	18-19	16-14	12
Net Energy- Lact (Meal/lb)	.78-.80	.74-.72	0.57
Acid Detergent Fiber (%)	19	21	27
Neutral Detergent Fiber (%)	28	28	35
Calcium (%)	.80-1.0	.80-.90	0.37
Phosphorus (%)	.40-.45	.35-.40	0.26

Herd Management and Health

Herd Health

Maintaining an effective animal health program is an essential part of a successful dairy enterprise. Good feeding and breeding may not pay if cattle are not kept in good health to get maximum production. Prevention rather than treatment should be the goal for animal health.

Losses due to health problems can amount to thousands of dollars each year. Economic losses occur because of lost milk production, poor animal gains, animal disease or injury, lost genetic capability, treatment cost, and extra labor.

Each owner should work with his/her veterinarian to develop a herd health program. Maintaining a healthy herd requires maximizing immunity against disease while minimizing exposure to disease causing organisms. Improving disease resistance includes proper colostrum management, a good nutrition and vaccination program and minimizing environmental and other stress. Minimizing exposure includes excellent environmental management (bedding, good ventilation and sanitation) and control of potential disease carriers such infected animals, rodents or equipment.

Observations and Records

Treating any disease is always more successful when diagnosed and treated early. Frequent observations help in early disease diagnosis. If diagnosis is in doubt, call your veterinarian. Pay attention to details and know your animals' normal behavior. This knowledge is an important characteristic of a good herd manager. Ask questions such as:

1. Is the animal aggressive and alert?
2. Are the ears droopy?
3. Is the animal hungry?
4. How does the manure look?
5. Is the animal dehydrated?
6. Is the animal breathing normally, coughing or has an abnormal discharge?
7. Have you seen these abnormal symptoms before?

Record all observations on a permanent record. As a general rule, observe cattle a minimum of twice each day. Routine recording of the animal's rectal temperature is a good method of detecting infectious diseases early. Normal temperature of dairy cattle is approximately 101.5°F.

Disease Immunity

Dairy cattle acquire protection against diseases in two ways. These are listed and explained below.

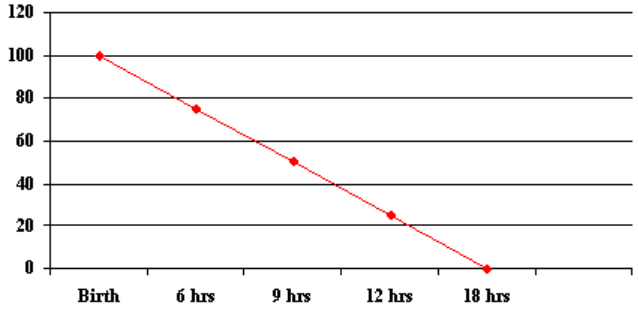
Passive immunity – Because antibodies cannot pass through the placenta, newborn calves are born without any natural immunity. They also have very limited ability to create their own immunity for several weeks after birth. Because of this they must acquire their immunity from consuming colostrum.

Colostrum is the first milk produced after birth. Colostrum is high in energy, vitamins, minerals and protein. In addition it contains special proteins called antibodies or immunoglobulins that are large proteins that provide immunity against disease. This is the calf's first and most important protection against diseases during the calf's early life. Having your cows on a good vaccination program will maximize the antibodies in the colostrum. There are specific vaccines designed to give to cows during late lactation and the dry period to prevent diseases such as rotavirus and coronavirus. A calf that does not receive adequate antibodies is said to have failure of passive transfer (FPT). One way to determine if your calves receive enough antibodies is to measure total serum protein with a refractometer between 2 and 7 days of age. The serum protein should be 5.5 mg/dl if adequate colostrum has been consumed.

The three keys to obtaining excellent passive immunity from colostrum are:

- Quality of colostrum – generally thicker colostrum is higher quality. A colostrometer is an instrument that can be used to measure the quality of colostrum.
    - older cows have higher quality colostrum
    - well vaccinated cows have higher quality colostrum
    - cows that leak milk before calving have lower quality colostrum
    - cows that produce less milk at first milking have higher quality colostrum
- Quantity of colostrum fed–the goal for Holsteins is to feed at least 4 quarts of colostrum as soon as possible after birth. Many aggressive calves drink this on their own, but for some calves you may need to use an esophageal feeder.
- Quickly feed the colostrum – the goal is to get the colostrum into the calf as soon as possible after birth and must be fed within 6 hours. A second feeding should be offered within the next 12 hours.

Because of a process called gut closure, within 24 hours after birth the calf is not able to absorb antibodies from colostrum. It is also important to harvest, store and feed colostrum with clean utensils.



Colostrum absorption over time
(http://www.farmllc.org/custom3.html)

Active immunity – The second way calves and adult cattle get disease protection is by manufacturing their own antibodies. This is known as active immunity. Beginning at a couple of weeks of age, a calf's immune system is developed enough to begin making some if its own antibodies and by 7-8 weeks after birth the immunity provided by the colostrum has diminished. The calf's immune system can be stimulated by exposure to an organism or through vaccination.

Vaccination Program

In setting up a vaccination program for your cows, it is important to work closely with your veterinarian so that you vaccinate for diseases of importance in your area and on your farm.

Vaccinating calves shortly after birth is not very effective because the antibodies from colostrum (passive immunity) interfere with the development of antibodies from the calf's own system (active immunity). This is especially true when calves have received adequate amounts of colostrum at birth. The passive immunity allows the calf's own antibody producing system to become more fully developed before the calf becomes dependent on it.

There are two types of vaccines, modified live (MLV) and killed vaccines. Modified live vaccines contain live organisms that have been altered so they cannot cause disease. Generally modified live vaccines result in improved level and duration of protective immunity, but only certain live vaccines are approved for pregnant animals, otherwise abortions can result. Killed vaccines usually require a second shot (booster) to achieve optimum protection.

Remember that exposure to disease on each farm varies; therefore, vaccination programs may vary from farm to farm. Follow the advice of your veterinarian since they are most knowledgeable on diseases in your area. If you administer vaccines yourself, follow directions carefully as to site of vaccination and care of the vaccine.

A vaccination program is an important component of a good herd health program. It does not replace a good colostrum feeding program, good nutrition, ventilation and sanitation to prevent disease.

Vaccines must be handled and stored properly to remain effective. Vaccines should be stored in the refrigerator at 40°F. Modified live vaccines must be reconstituted by mixing a diluent (liquid) with the vaccine (solid). Only mix the vaccine that will be used in 1-2 hours. It is also important to sterilize syringes with boiling water only. Chemicals may react with the killed vaccine and may kill a modified live vaccine rendering them ineffective. Remember an animal's immune system must respond to the vaccination in order to build antibodies against the diseases. Therefore, only vaccinate healthy animals.

Minimizing Stresses

Plan your herd health program carefully so that you minimize stress to your dairy cattle. Dehorning, vaccinating, weaning, and moving a calf to a group pen all at the same time can be very stressful to a calf's health. The spacing of vaccinations and other routine herd health procedures will minimize stress and help ensure good health in your animals.

Here are examples of stressors that will challenge the animal's immunity making a disease outbreak more likely:

- irregular feeding schedules, feed or water deprivation
- a poorly balanced diet
- feeding moldy or poor quality feeds
- poor ventilation
- overcrowding, lack of feeding space
- sudden weather changes, heat or cold stress
- transportation
- vaccination
- weaning, dehorning, castrating, re-grouping

Common Diseases affecting Dairy Cattle

1. **Calf Diarrhea (scours)**
   Scours is the most common cause of death in calves less than three weeks old.
   Viral causes: Bovine Virus Diarrhea (BVD); Roravirus; Coronavirus; Infectious Bovine Rhinotrachitis (IBR)
   Bacterial causes: E. coli; Salmonella
   Protozoal causes: Coccidiosis, Cryptospirosis
   Symptoms: Fever with watery feces. Animal may be cold to the touch with sunken eyes. Skin slowly returns to normal after being pinched up (a sign of dehydration).
   Major contributing factors are low passive immunity (lack of colostrum) and housing calves in a wet, dirty environment. Other contributing factors include poor ventilation, high humidity and overcrowding. A rapid change in feed may contribute to scours.
   Prevention: Feed colostrum at birth. Sanitize feeding equipment. Keep calves clean, dry and comfortable. Vaccinate dams in third trimester with specific agent to build colostral antibodies.
   Treatment: Most deaths are caused by dehydration, not the infectious agent. Because of this the most important treatment is to get plenty of fluids into the calf. Continue to feed milk or high quality milk replacer + feed electrolyte solution between milk feedings until feces become firm. A homemade electrolyte solution could include 1 package of fruit pectin, 1 tsp. low sodium salt, 2 tsp. of baking soda, 1 can of beef consommé, and 2 quarts of warm water. Good commercial electrolytes are available and supportive treatment with antibiotics may be warranted. In severely dehydrated calves intravenous (IV) treatment may be necessary.

   Clinical symptoms that help evaluate amount of dehydration in calves[1]

Dehydration percent	Symptoms
5-6	Diarrhea, no clinical signs, strong sucking reflex
6-8	Milk depression, skin tenting 2-6 seconds, calf still sucking, sunken eyes, weak
8-10	Calf depressed, laying down, eyes very sunken, dry gums, skin tenting >6 seconds
10-14	Calf will not stand, cool extremities, skin won't flatten when tended, comatose
Over 14%	Death

   [1]Kehoe & Heinrichs, http://www.extension.org/pages/Electrolytes_for_Dairy_Calves

2. **Pneumonia**
   Pneumonia is the second leading cause of death in calves and is the major health concern from one to six months of age. It can be caused by either viruses or bacteria. Pneumonia causes inflammation and if not treated rapidly can lead to permanent lung damage.
   Symptoms: Rapid and difficulty breathing, cough, runny nose and eyes with a fever of 103-106°F.
   Major contributing factors: Housing calves in area of high humidity with poor ventilation and wet, dirty pens. Wide fluctuations in temperature, poor nutrition, and overcrowding also may contribute.
   Prevention: Adequate colostrum and clean, dry and comfortable housing with good ventilation are keys to preventing pneumonia. Make sure young calves are not downwind from older animals. Isolate young calves in individual stalls or pens. Vaccination program may be helpful
   Treatment: If possible isolate sick calves and provide antibiotic therapy for 3-5 days.

3. **Winter scours (adult cattle)**
   Symptoms: Scouring that strikes suddenly and spreads rapidly. Large volumes of watery diarrhea is main sign, feces may contain blood. Typically many animals within the herd are affected with a rapid drop in milk production. Frequent in confined cattle between November and March
   Causes: May be viral.
   Prevention: Isolate newly introduced animals for two weeks.
   Treatment: Most animals recover spontaneously in 2-3 days. Differentiate from other diarrheal diseases. Intestinal boluses (astringents and buffers) and electrolytes may help in severe cases.

4. **External Parasites**
   <u>Flies</u>
   Symptoms: Presence of various types of flies
   Causes: Poor sanitation and decaying feed, manure or other organic matter providing breeding grounds for flies.
   Prevention: Cleanliness.
   Treatment: Proper use of insecticides.

   <u>Lice</u>
   Symptoms: Hair loss and rough coat with lots of rubbing and itching. There are two types of lice, biting and sucking. May become anemic if infected with the sucking lice.
   Causes: Seasonal problem, greatest in winter.
   Prevention: Routine use of lice control powders or liquid pour ons, especially during early and mid-winter months. Clip hair along topline.
   Treatment: Same as prevention.

5. **Warts**
Symptoms: Gray, crusty nodules on skin, usually on head or shoulders
Causes: Contact with other cattle that have contagious—warts
Prevention: Good sanitation, vaccination
Treatment: Vaccination or manual removal

6. **Mastitis**
Mastitis is the most costly disease in dairy herds. Total losses average $200/cow/year. Is considered contagious or environmental, depending on the causative organism.
Contagious – Strep Agalactiae, Staph Aureus, Mycoplasma
Environmental – E. Coli, Klebsiella, Strep Uberis, Staph Epidermidis, Yeast
Symptoms: Infection of mammary gland caused by one of several bacterial organisms. Cows will have elevated somatic cell counts, flakes or lumps in milk. They may have a swollen and painful udder and in severe cases may go off feed. If cows have an elevated somatic cell count but no clinical signs, the cow is described as having sub-clinical mastitis. If the cow has clinical signs, they are described as having clinical mastitis.
Causes: Dirty environment. Improper milking procedures. Faulty equipment. Mastitis in other cows. Udder and teat injuries.
Prevention: Follow proper milking procedures. Provide a clean dry environment. Dry cow treatment. Teat dip after milking. Properly designed and installed milking system that is maintained regularly. Vaccination for coliform mastitis will not prevent the disease but will lessen the severity of the infection.
Treatment: The most effective treatment is dry cow therapy. Promptly treat cases with appropriate antibiotics or other therapy. Cull problem cows.

7. **Grass tetany**
A metabolic disease of cows grazing lush high protein pastures in early spring.
Symptoms: Similar to milk fever; muscle tremors, down cow and if untreated death can result
Causes: Magnesium deficiency
Prevention: Add magnesium to ration
Treatment: Magnesium and calcium IV

8. **Ring worm**
Ringworm is a fungal disease that commonly affects heifers, especially heifers housed in facilities where previous calves were infected with ringworm.
Symptoms: Gray, crusty patches on skin, usually on head and shoulders
Causes: Infected housing or animals
Prevention: Difficult to eliminate fungus from environment, adequate vitamin A, a balanced ration and sunshine lessen severity.
Treatment: Exposure to sunshine, scrape off crust and apply iodine, bleach or other effective solutions. Another treatment is to orally give Griseofulvin.

9. **Lameness/foot diseases**
Lameness is the biggest animal welfare concern of dairy animals. There are many causes for lameness in dairy cattle. In freestall barns between 18-30% of all cows are lame. The average economic loss is over $300 for every case of lameness. Over 90% of all lameness occurs on the rear feet, with the outside claw being most affected. Lameness is seasonal with more lameness in the summer and early fall.
Symptoms: Lost milk production. Cows favoring one foot or visibly limping, abnormal walking. Swollen feet or observation of lesions.
Causes:
Infectious diseases
Foot rot: Bacteria. Characteristic strong odor. Wet, muddy environment. Foot rot in other cattle.
Digital Dermatitis: This is a very painful lesion below the pastern in the epidermal area of the skin caused by bacteria. It is better known as hairy heel warts. Wet manure conditions. Introduction of infected cattle.

Non-Infectious diseases
Laminitis/Toe and Sole Ulcers/White Line Separation: One potential factor in all these diseases is rumen acidosis caused by feeding too much starch or sugar or not enough fiber. Another potential cause is uncomfortable stalls/lack of bedding causing cows to stand on concrete for extended periods of time.
Prevention: All foot diseases can be minimized by providing clean, dry yards and regular removal of manure, preventative hoof trimming and regular use of foot baths. To prevent infectious disease, practice good bio-security to prevent introduction of the organisms. For prevention of non-infectious diseases feed a diet with adequate fiber and provide comfortable stalls with adequate bedding for cows to lie down.
Treatment: Regular use of foot baths. Antibiotics for severely infected animals.

10. **Hardware disease** (traumatic gastritis)
Symptoms: A sudden lack of appetite. Reluctance to move with a rapid respiration rate. Often a temperature of 103° F or higher.
Causes: Cattle consuming metal such as nails or wire.
Prevention: Give cows magnets. Magnets on TMR mixer.
Treatment: Magnets and antibiotics. Surgery in severe cases.

11. **Displaced abomasums** (Twisted stomach)
Abomasum moves in the body cavity preventing passage of feedstuffs. Feces often firm. Diagnosis is by using a stethoscope to hear pinging sound like a hollow basketball.
Symptoms: Cow eats very little.
Causes: Lack of fiber feeding during the transition period. DA is often secondary to other diseases that cause the cow to quit eating. Examples are milk fever and ketosis.
Prevention: Maintain adequate fiber level during the transition period. Prevent other diseases that cause cows to quit eating.
Treatment: Surgery or roll cow and pin the abomasum in the proper location.

12. **Udder edema**
Symptoms: Swelling in udder near calving. More common and severe in first calf heifers.
Causes: Feeding too much salt or potassium before calving.
Prevention: Proper nutrition during dry period
Treatment: Diuretics, udder massages or both

13. **Parturient Paresis** (Milk fever)
Occurs primarily at calving due to the greatly increased demand for calcium to make colostrum.
Symptoms: First sign is staggering, difficulty in rising; finally down and unable to rise. Cows usually lying on their sternum with head bent back toward flank
Causes: Feeding high DCAD (dietary cation anion difference) diet during the close up period. This is usually from feeding forage too high in potassium. Older cows and Jersey's are more susceptible
Prevention: Feed a low or negative DCAD diet during last few weeks prior to calving.
Treatment: Calcium gluconate IV

14. **Bloat**
An excessive accumulation of gases in the rumen.
Symptoms: Distended rumen on the left side of the animal. Breathing becomes labored and excessive salivation is common.
Causes: Mostly on new, highly productive pastures, especially in pasture containing a high percent of lush alfalfa.
Prevention: Maintain pastures to less than 50% alfalfa. Feed cows stored feeds before grazing. Feed recommended levels of bloat-preventing drugs.
Treatment: Tube stomach to release gas and drench with mineral oil or commercial product. Use trocar on left side if bloat is severe.

15. **Navel ill**
Symptoms: Listless, poor appetite, high fever, thickened, hot navel cord, swollen joints
Causes: Colostrum not fed at birth or low in antibodies. Wet, dirty maternity facilities.
Prevention: Use navel clips. Dip navel in a tincture of 7% iodine at birth. Sufficient colostrum and sanitize maternity pens.
Treatment: Intensive antibiotic therapy

16. **Johne's**
It is estimated that 68% of dairy herds have animals infected with Johne's. Johne's is a challenging disease because calves are usually infected in the first couple of weeks after birth, but symptoms do not appear until the infected animal is 3 years old or older.
Symptoms: Animals have a normal appetite but have rapid weight loss and chronic diarrhea that does not respond to treatment. Milk production drops dramatically.
Causes: Caused by the bacterium mycobacterium paratuberculosis. Animals are infected by consuming manure from infected cows either through contaminated colostrum or in maternity pens.
Prevention: Immediately remove calves from maternity pens. Feed colostrum replacer or colostrum from test negative cows. Clean maternity pens between each calving. Calve cows that have tested positive for Johne's in separate maternity pens. Cull all cows that test positive for Johne's. Use AI bulls that are high for PTA Productive Life as their daughters will be more resistant to Johne's infection.
Treatment: There is no treatment. Cow showing clinical signs should be culled promptly.

17. **Ketosis** (Acetonemia)
Ketosis is a metabolic disorder characterized by low blood sugar from reduced feed intake during times of negative energy balance. If not treated, may lead to fatty liver syndrome. Usually occurs between 1 to 6 weeks after calving.
Symptoms: Animals have reduced feed intake resulting in a decrease in milk production. Often the smell of acetone can be detected on affected cow's breath. Body temperature is normal. Can be diagnosed with a blood, urine or milk test.
Causes: Caused by rapid weight loss resulting in elevated ketones. Often a problem with over conditioned cows that lose weight rapidly after calving.
Prevention: Prevent over conditioning of cows during late lactation or during the dry period. Provide adequate bunk space and a well balanced palatable diet during the transition period. Feeding rumen protected choline (B-vitamin) during the close up and fresh period, especially to over conditioned cows, is effective in preventing the disease.
Treatment: IV with dextrose or oral drench with propylene glycol

18. **Blackleg**
Blackleg is caused by a spore forming bacteria.
Symptoms: Sudden death with swelling in a limb or limbs of animal or swelling in rear area
Prevention: Vaccination. Burn or bury carcasses. Prevent overgrazing of pastures
Treatment: Death is usually rapid of treatment is ineffective

19. **Vibriosis**
Caused by bacterium
Symptoms: Blood tests, abortions in middle third pregnancy. Several services per conception with irregular heat periods.
Prevention: Use AI. It is only transmitted through the use of natural service. Vaccination yearly if bull breeding.

20. **Leptospirosis**
Can be identified with a blood or urine test. Caused by bacterium. Is a zoonotic disease (humans can contract the disease from cattle)
Symptoms: Abortions in second and third trimester, low conception, bloody urine and loss of milk production.
Prevention: Vaccination

21. **Brucellosis**
Caused by a bacterium. Is a zoonotic disease and the human disease is called undulant fever. Can be diagnosed with a blood or milk ring test. All states are considered brucellosis free.
Symptoms: Abortions in last third of pregnancy. High services per conception
Prevention: Calfhood vaccination at 4-8 months
Treatment: None

22. **Shipping fever**
Generalized respiratory disease caused by the bacteria Mannheimia and Pasteurella.
Symptoms: High fever and nasal discharge with coughing. Cattle can have rough hair coat if severe. May be complicated by or confused with viral infection
Prevention: Vaccination

23. **Infectious bovine rhinotracheitis** (IBR)
Respiratory disease caused by a virus. Can be identified by virus in blood or tissues. Commonly known as red nose.
Symptoms: High fever with nasal discharge or coughing. Can cause pus pockets in the vagina with abortions.
Prevention: Vaccination
Treatment: None

24. **Parainfluenza-3** (PI_3)
Respiratory disease caused by a virus.
Symptoms: Affected animals exhibit watery to yellow-colored discharges from the eyes and nose, coughs, increased respiration rates and fever, similar to shipping fever.
Prevention: Vaccination
Treatment: None

25. **Bovine viral diarrhea virus (BVD)**
Caused by virus. Can be identified by milk, serum or ear notch tissue test. Often spread in herd by a persistently infected (PI) animal. PI animal are infected between 45 and 125 days in gestation. The animal does not recognize the virus as a foreign virus and the PI animals shed the virus in large numbers. PI individuals are often unthrifty but may not exhibit any symptoms of disease.
Symptoms: Symptoms include profuse, watery diarrhea (which may contain blood and gut lining), fever, depression and lack of appetite. There are sometimes lesions on the lips and tongue. There may be abortions, high fever and coughing.
Prevention: Vaccination
Treatment: None

26. **Bovine respiratory syncytial virus** (BRSV)
BRSV is a respiratory disease caused by a virus. It is primarily in heifers.
Symptoms: Infected animals have a mucous discharge from the nose and eyes with increased temperatures and increased respiration rates. Infected animals may have decreased appetites and appear slightly depressed.
Prevention: Vaccination
Treatment: None

27. **Pinkeye** (Infectious bovine keratoconjunctivitis)
Pinkeye is caused by the bacteria Moraxella Bovis. It is typically spread by face flies
Symptoms: Inflammation and watery eyes with a reddening of the eyeball. Advanced pinkeye may include cloudiness of cornea.
Prevention: Good fly control and vaccination
Treatment: Treat with antibiotics and/or commercial sprays or patches on eye.

Housing for Calves and Cows

The dairy housing facilities need to meet several criteria:

1. Provide for the health and well-being of the animal
2. Provide for labor efficiencies
3. Meet environmental and safety codes
4. Be economical
5. Provide a safe and desirable working environment for laborers

Calf and Heifer Housing

The housing needs of calves and heifers will vary depending upon their age. The groups to plan for include:

calf housing (0-2 months)

transition housing (3-5 months)

heifer housing
(6-8 months)
(9-12 months)
(13-15 months, breeding age heifers) and
(16-24 months, bred heifers).

Calf Housing (0-2 months)

It is generally recommended that young calves be separated from older animals to prevent respiratory and other diseases. Calves need a dry, draft-free environment. Hutches or individual pens in a larger building are the most common housing arrangement for calves.

Individual calf stalls in building

Calf hutches are an economic way to house calves. Most hutches provide about 32 square feet per calf or are about 4 by 8 by 4 feet. Hutches are commonly constructed of plywood, or molded from plastic or fiberglass. Hutch fronts should face south or east in the winter in cold climates to provide calves exposure to the sun and protection from cold winds. Avoid placing hutches under exhaust fans downwind from older animals or manure systems to prevent contaminated air from ventilating hutches. Shade is desirable for translucent hutches (such as polydomes) in the summer. Adequate bedding needs to be used so that calves stay dry and comfortable. Individual pens in a building are also a popular way to house calves. This type of housing provides more comfort and convenience for the person taking care of the calves but is more costly to construct. Pen size is typically about 4 by 8 feet. There should be solid partitions between pens or pens should be placed two feet apart to prevent nose to nose contact. Adequate ventilation is important.

Recently a new method of housing and feeding calves has gained popularity. This is the use of group housing with a computerized feeding station containing a nipple to feed the calves. A computer recognizes each calf as it enters the feeding station from a collar or Radio Frequency Identification (RFID) tag. The computer tells the robot to mix and dispense milk replacer or milk to each calf based on criteria provided by the calf manager. The computer determines how much milk the calf is allowed to have per feeding and over the entire day. Up to 25 calves are housed together in one group (with one nipple) and pen should provide at least 28 square feet of space per calf.

Ventilation is key to preventing respiratory diseases and stress. Proper ventilation provides fresh air while removing moisture, animal heat, and pathogens while preventing a draft on the calves. Cold housing (inside temperatures close to outside temperatures) is preferable to a warm, insulated building with mechanical ventilation. Most newer calf barns have tubes to evenly distribute fresh air throughout the barn.

Calf barn with computerized calf feeder and tube ventilation

Transitional Housing (3-5 months)

Transition housing should allow the calves to adjust from their individual pen to a small group with minimal stress. Here heifers learn social behavior and begin competing with other animals. It is best for the first grouping to contain no more than 10 calves. Time in the transition pen should be at least 6 weeks. Calves need to be close to the same size and age and should be moved into the transition housing at the same time. There should be 25 to 30 square feet of bedded area per calf with feed and water available at all times.

Super hutch for transitional housing

Super hutches can provide very economic transitional housing for calves. These hutches are designed so that they can be moved between groups of calves so that the new group of calves is always on fresh ground. Transition pens also can be built in larger barns. Adequate ventilation is extremely important for calf health. These are generally naturally ventilated cold barns.

Heifer Housing (6-24 months)

Shelter is not nearly as critical for heifers as they get larger and there are many different options in use. Animals still need to be grouped by size and housing should allow for easy observation and handling facilities for breeding and treatment. Headlocks or squeeze chutes are both excellent ways to handle heifers in a labor efficient manner that is also safe for the animal and operator.

Open front heifer shed with drive by feeding

Common ways to house heifers are open front bedded pack or freestall buildings divided into pens with outside drive by feeding. The building should be designed to minimize labor requirements during feeding and manure removal. Heifers can also be successfully raised outside year round on pasture or in open lots with dirt mounds if they are provided shade in the summer, and adequate bedding and protection from wind in the winter.

Housing the Milking Herd

Four types of housing are common for housing dairy cows: stall (or stanchion) barns, loose housing bedded pack barns, freestall barns and open corrals with a shade.

Stall Barns: Traditionally, stall barns have been the most popular housing system in the Midwest and Northeast. As herd size has grown, stall barns are being replaced by freestall barns with milking parlors. The main advantage of stall barns is the chance for greater individual attention to cows. Main disadvantages of stall barns are operator long term health (knee, back and shoulder injuries), and very high labor requirements per cow.

Loose housing bedded pack barns: Loose housing is a barn with a large open bedded area where cows can lie down. A major advantage of loose housing barns is great cow comfort. Cows should be provided with 80 square feet of lying area per cow. Bedding sources are usually straw, corn stalks. A new type of bedded pack barn is becoming more popular for moderate size herds. It is called a compost bedded pack barn. In this type of barn the bedding is usually sawdust, fine wood shavings or finely ground straw. The main difference between a traditional bedded pack barn and the compost bedded pack barn is that the compost barn is tilled 8-12 inches deep twice daily to mix the manure and bedding. This mixes the manure and bedding and injects air into the pack resulting in heating of the pack that dries the top of the pack and keeps the cows cleaner. The main disadvantage of bedded pack barns is the high cost of bedding and if not bedded adequately, cows can become dirty and somatic cell count will increase.

Tie stall barn

Compost bedded pack barn

Freestall Barns: Freestalls are rather simple in design and must provide a clean, comfortable resting space for cows. Cows should be able to lie down and rise in the stalls using a natural movement. As cows rise naturally, they lunge forward, transferring weight forward allowing them to rise more easily on their rear legs. Freestalls must be designed so cows have the needed lunging space.

Improperly designed stalls can result in the cows' refusal to use the stalls, standing in stalls, lying back too far or lying too far forward, difficulty rising, swollen hocks, leg injuries, and injured teats.

Table 1 - Recommended Freestall Dimension for Dairy Cows

Cow Weight	**Total Length**	**Width**	**Height of curb**	**Rear curb to brisket board/neck rail**
1400 lb	98 in	47 in	8-12 in	66 in
1600 lb	106 in	51 in	8-12 in.	70in

Many different bases for freestalls have been used successfully over the years, including sand, recycled manure solids, mattresses and soft mats. Sand is considered the "gold standard" of freestall bases. This is because it provides excellent cow comfort and being an inorganic material it does not support the growth of mastitis causing bacteria.

Deep bedded recycled manure solids also provide excellent cow comfort. A major disadvantage of manure solids is that bacteria can grow rapidly causing a higher somatic cell count and increase in clinical mastitis cases.

Mattresses generally consist of tubes of shredded rubber with a cover. Soft mats are constructed of rubber and are typically 2-3 inches thick. For good cow comfort 2-3 inches of bedding such as chopped straw or sawdust must be maintained on top of the mattresses or mats.

Comfortable freestall barn

Open Corrals: In warmer, drier areas of the southwestern United States, cows are usually grouped into dry lot corrals providing about 350 square feet per cow. Characteristics of these corrals include concreted areas at the feed platforms, around drinking tanks and near gates where cow traffic patterns are heaviest. Feed is fed along fence lanes by a feed wagon or truck. Elevated shelter areas usually are provided to help keep cows clean during the rainy season and provide shade during hot weather. These shelters often contain fans and misters to keep cows cool during hot weather. Investment per cow is generally lower for corrals than other housing systems.

Grouping of Cows

Housing should be designed so that cows can be grouped by production and other management considerations. Following is a sample of possible management groups:

Grouping of lactating cows – Lactating cows can be grouped several ways. Generally maximum group size should be dictated by parlor throughput. On herds milking twice per day, cows should not spend more than one hour in the holding area per milking. For herds milking three times per day, cows should only be in the holding area for 45 minutes per milking.

- By age – research has shown that grouping 1st lactation cows separate from older cows will result in a 10-15% increase in dry matter intake and milk production.
- By production – grouping by production allows each group to be fed closer to their nutrient requirements. This may result in increased production or lower feed costs. This may also prevent lower producing late lactation cows from becoming overweight.
- By reproductive status – grouping all open and/or pregnant cows together allows heat detection and breeding to be focused on a fewer number of pens saving labor and possibly resulting in better reproductive performance.
- By disease status – most herds have a sick pen to allow them to take special care of sick cows. Other herds have a special pen dedicated to herds with Staph Aureus mastitis to prevent it spreading to other cows.

Other possible grouping strategies:

Cows three weeks prior to calving – This will allow cows to have a separate transition ration. It is also important that these cows be in a clean, non-stressful environment where they can be observed for calving signs frequently.

Cows at calving – Cows need to be kept in an area where they can be observed frequently. If individual maternity pens are used, they should measure a minimum of 12 by 12 feet or 10 by 14 feet. The cow needs a clean environment with a non-slip floor. Provisions should include a way catch cows to assist with calving as needed and a method to collect colostrum to feed the calf.

Fresh cows (0-21 days after calving) – Feed intake and milk production should be monitored and cows observed often to make sure they get off to a good start on their lactation. On many farms the temperature of fresh cows are taken every day for the first week.

Dairy Barn Ventilation

Dairy barn ventilating systems must provide air exchange between the inside and outside of a barn to help keep dairy cattle and those working with the animals healthy and comfortable. The air exchange:

1. Provides fresh air throughout the barn
2. Removes moisture from the building
3. Removes excess heat during hot weather
4. Removes gases and odors from the barn

Ventilating systems must be flexible so that they can operate correctly over a range of outside temperatures and weather conditions.

Air exchange can be provided by either natural ventilation or power ventilation.

Power ventilation, also called mechanical ventilation, uses fans to provide air exchange between the inside and outside of a barn. It is most common in cold climates to mount the fans to blow air out of the barn. The fans blowing air out of the barn create a small vacuum inside the barn which draws fresh air from outside into the barn through planned inlets. Cross-ventilated barns and tunnel ventilated barns are common examples of mechanical ventilating systems used in dairy barns.

Cross-ventilated barns are completely enclosed with all of the exhaust fans on one side of the barn and evaporative pads to cool the air on the opposite side of the barn. In cross-ventilated barns freestall rows are aligned so that the air is drawn across the freestall rows. The advantage of cross-ventilated barns is that air flow is controlled and they are cooler in the summer and warmer in the winter. The disadvantage is the fans must be run continuously for proper ventilation. Automatic stand-by electric generators are required to power the fans whenever there is a power failure.

Tunnel ventilated barns are completely enclosed too but the air is drawn down the length of the barn. Tunnel ventilation can be used in tie-stall barns and freestall barns. The exhaust fans are on one end of the barn and planned inlets are on the opposite end of the barn. Tunnel ventilation is used to remove excess heat in hot weather. Other fans and inlets are needed to ventilate the barn in cold weather.

Natural ventilation is the air exchange without fans and commonly used for freestall barns and compost barns. Air exchange is provided by wind and thermal buoyancy (warm air rises). In naturally ventilated barns fresh air enters through open sidewalls on the upwind side and leaves through the downwind side and an open ridge along the peak of the roof. Moist and warm air escape through the open ridge. The sidewalls can have adjustable curtains or panels. Inside temperatures are within a few degrees of outside temperatures year round. Inside temperature can drop below freezing in cold weather which is a disadvantage of natural ventilation in cold climates. Natural ventilation is dependent on wind to provide air exchange. Naturally ventilated barns should be located in open areas where summer breezes can reach the barn and provide air exchange during calm weather when wind speeds are very low. Natural ventilating systems do not require fans to provide air exchange.

Dairy cows are subject to heat stress in hot and humid weather because they have trouble getting rid of heat generated by digestion and metabolic processes. Cows experiencing heat stress have reduced milk production and reproductive performance. Heat stressed cows will have increased respiration rates, water intake and sweating and decreased dry matter intake. Tools for fighting heat stress include providing plenty of fresh clean drinking water, increasing ventilation air exchange, increasing air velocity at cow level, using low-pressure sprinklers, high-pressure misters or evaporative cooling pads.

Mixing or cooling fans can be installed in dairy barns to increase the air velocity at cow level. The fans can be mounted to blow air across the cows while they eat along the feed manger, lay in the freestalls or stand in the holding area prior to milking. It is important to have the fans mounted so that the air flows downward across the cows.

Low-pressure sprinkler systems, high-pressure misting systems and evaporative cooling pads produce cooling by evaporating water. Evaporation converts liquid water to water vapor. It takes energy to evaporate water and as water evaporates the energy source is cooled. The low-pressure sprinkler system gets the energy from a cow's skin. The high-pressure misting system and evaporative cooling pads get the energy from air. Low-pressure sprinkler systems can be located by feed mangers or in holding areas. Low-pressure sprinklers combined with cooling fans can be very effective.

Some barns or rooms like the milk room and equipment room are kept warm and heated during cold weather. The components of a warm housing ventilation system include:

1. Insulation in walls and ceiling to prevent condensation and reduce heat loss through the walls and ceiling
2. Adjustable air inlets
3. Ventilating fans and heaters
4. Thermostats to control the fans and heaters

In a warm housing system, the temperature is generally kept above freezing regardless of outside temperatures. Adequate ventilation in barns that house dairy animals requires four air changes per hour in the winter and 20 air changes per hour in summer. Tie stall barns are warm barns.

Milking Management

The Mammary Gland

The cow belongs to a class called *mammals*, which have certain characteristics, one of these being the ability to produce milk from *mammary or milk glands*. Most mammals produce only enough milk for the period of time to feed their young. Through the process of genetic selection and improved nutrition and management, some mammals, most notably the dairy cow, have obtained the ability to produce large quantities of milk for long periods of time and provide milk for people.

The mammary gland is a unique organ. The role of the mammary gland is to 1) remove nutrients from the blood that mainly originate from digestion and absorption of feedstuffs, 2) process and synthesize these nutrients into milk components and secrete them into the gland, and 3) provide a mechanism (milk letdown) and transport system to allow milk to be removed efficiently. The mammary gland is really a milk factory with very delicate and sophisticated machinery that requires proper care and attention to work properly (figure 1).

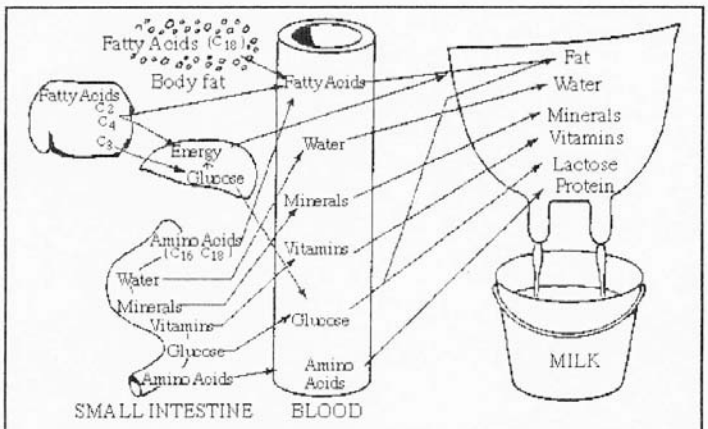


Figure 1. Mammary Gland as a Milk Factory.

A cow's mammary gland or udder is located almost entirely outside the body. It weighs 25 to 80 pounds without milk and can hold more than 100 pounds of milk. The mammary gland has its own circulatory, nervous, and lymph systems to provide elements for making and harvesting milk as well as protecting the gland from injury and disease. The cow's mammary gland has four separate and distinct quarters with each having its own physiological systems and each being drained by one teat. The median suspensory ligament (membrane that divides the right and left udder halves) is the primary support system for the entire udder (figure 2).

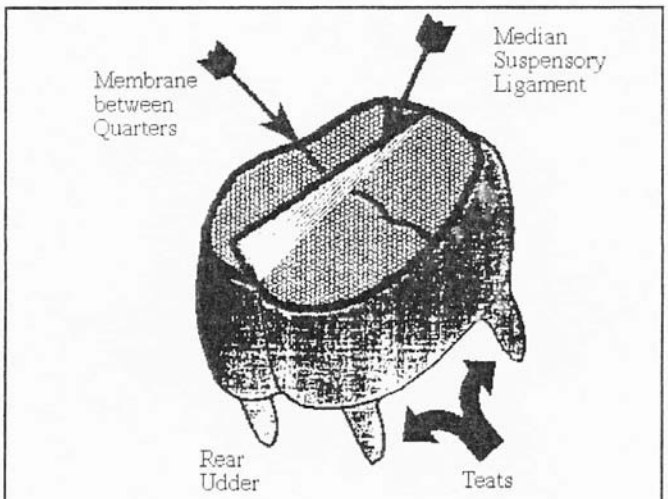


Figure 2. Parts of a Cow's Udder.

Milk exits the mammary gland through the streak canal. Surrounding this canal are circular muscles called teat sphincter muscles, which impact the canal closure. This is an inherited trait and can influence milking speed (slow if tight) or mastitis (leak milk if too loose). Inside the streak canal is a waxy substance called keratin, which helps prevent mastitis organisms from entering the gland. The teat wall or tissue has an extensive blood and nerve network. The inside of the teat is a hollow cavity called the teat cistern, which connects to the gland cistern at the bottom of each quarter. These are milk storage areas but only hold 1 to 2 cups of milk. Large milk ducts (5 to 20) empty into each gland cistern. These large ducts continually rebranch into many more small milk ducts as they spread through the quarter. At the end of each small duct is an alveoli, or area where milk is made and stored.

There are approximately 1,000,000 alveoli per cubic inch of udder tissue. A single alveolus is comprised of a single layer of epithelial or milk producing cells that extract nutrients circulating in the blood, synthesize milk components, and secrete them into a hollow area or lumen and ducts for storage until milking. Surrounding the epithelial cells are blood vessels that transport nutrients and hormones for milk synthesis and harvest or letdown. Approximately 300 to 500 pounds of blood must pass through the udder for each pound of milk produced. Also surrounding these cells are myoepithelial or muscle cells which are essential for milk letdown (figure 3).

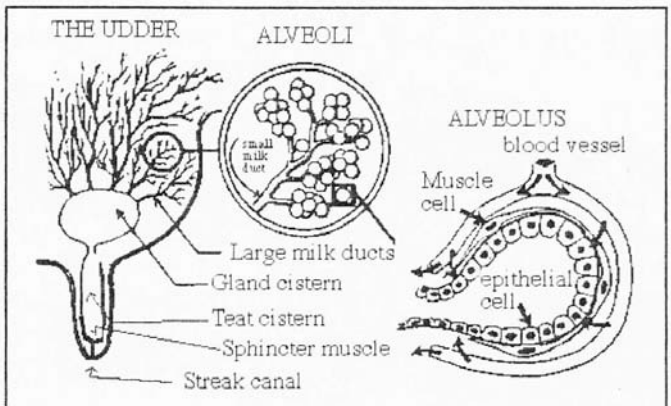


Figure 3. Anatomy of the Mammary Gland.

Harvesting Milk

The efficient, proper harvest of milk is essential to maximize profitability by maximizing returns on investments made in breeding, feeding, housing, and caring for dairy animals. The primary goals of milk harvest or milking time are 1) obtain the highest quality and quantity of milk; 2) complete the task in an efficient amount of time; and 3) minimize risks of injury or mastitis to the mammary gland. This only can be accomplished by understanding the milk letdown process of the cow, and using proper milk harvesting techniques and equipment.

Milk Letdown

The mammary gland is like a sponge where milk is continually made and fills up the alveoli and small ducts. The process of milk letdown allows this milk to be "wrung out" of the mammary gland. The milking routine must be organized to take maximum advantage of milk letdown. When this is not accomplished, less milk is harvested, it takes more time to milk, and unharvested milk can fuel mastitis organisms. This contradicts all milk harvest goals.

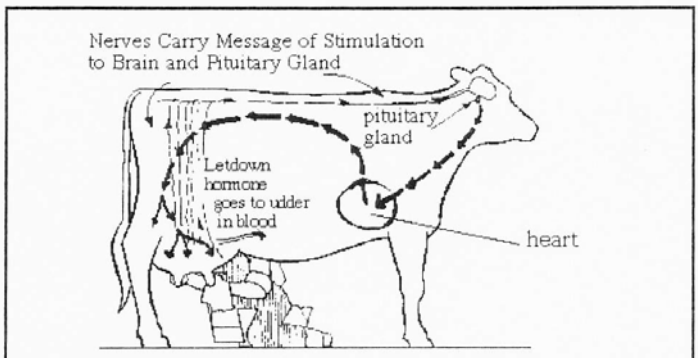


Figure 4. How Milk Letdown Occurs.

Preparing and sanitizing the teats prior to milking allows nerves in the teat to be stimulated. A nerve impulse is rapidly sent to the brain. The pituitary gland at the base of the brain releases oxytocin into the blood. Oxytocin then goes to the mammary gland, causing the myoepithelial cells to contract, thus creating pressure within the udder and forcing milk down to the teats (figures 4 and 5).

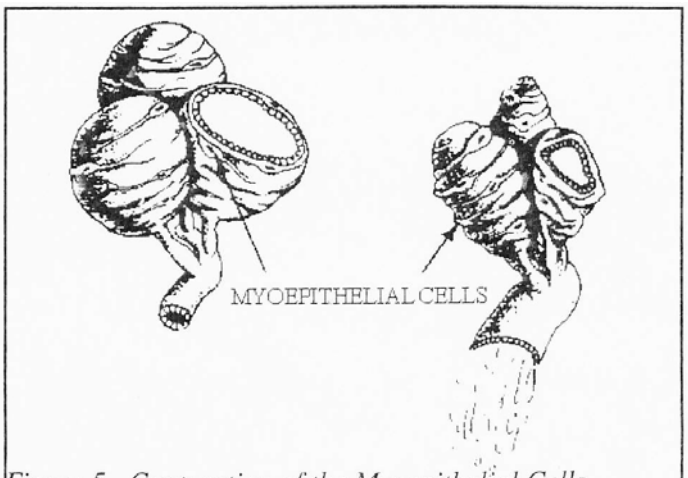


Figure 5. Contraction of the Myoepithelial Cells.

Maximum oxytocin and pressure is achieved within 1 to 2 minutes. The kidney and liver remove oxytocin from the system, thus diminishing the oxytocin effect and a cow's cooperation after 5 to 7 minutes (figure 6). This is why it is imperative to attach a milker unit within 1.5 to 2.0 minutes after initiating stimulation in order to achieve complete yet rapid or efficient milkout.

It is also important to milk cows using a proper, consistent routine and comfortable environment since any stress or irritation results in the cow releasing another hormone, *adrenaline*, which blocks milk letdown.

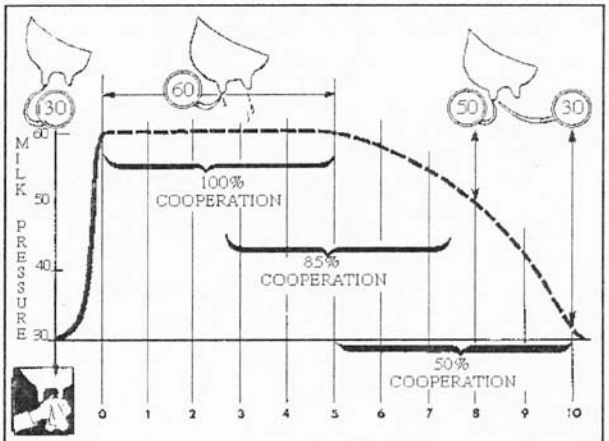


Figure 6. Effects of Time on Milk Pressure.

Milking Practices and Procedures

Proper milking practices are essential to insure rapid, complete milkout with minimal udder irritation or injury. They are also essential for maximal milk quality by minimizing external bacteria and other contaminants from entering the milk or cow. A proper and comfortable milking environment is the first place to start. Organization of a standardized milking routine is important to assure all tasks are performed properly

in a timely manner and similarly among all personnel responsible for milking. The milking machine should be properly sanitized prior to milking and milkers should wear disposable sanitary gloves to minimize bacterial contamination and mastitis risks.

Premilking Sanitation

Stimulate and Sanitize Teats
This is best accomplished through a combination of teat dipping, manual manipulation of teats to clean teat surfaces, forestripping, and a drying step. When predipping, use a clean dip cup with fresh dip. Teats should be reasonably clean before predipping and pre-dip should cover the entire teat. *A minimum of 30 seconds* contact time is needed for adequate predip contact to achieve proper bacterial kill. Removal of any dirt or manure from teat surfaces including the teat end is critical to producing high quality milk and minimizing mastitis.
Check for Abnormal Milk
A few streams of milk should be stripped into a *strip cup* or onto the parlor floor to evaluate the milk for abnormal milk and *early mastitis detection*. Forestripping is an excellent milk letdown stimulus and removes a milk fraction that may be high in bacteria, sediment, and somatic cells.

Drying teats is an essential step. Teats should be thoroughly dried with an individual towel or cloth to minimize any bacterial or chemical residue contamination. Good drying also stimulates milk letdown, and reduces chances for teat cup slippage or squawking. This is important because when excess air is let in the teat cup like a squawk, this creates a vacuum fluctuation and is the major mechanism by which the milking machine can spread or influence mastitis. Special attention should be paid to wipe off the teat end. Since this is the areas where bacteria that may cause a new udder infection most likely to originate from.

Milker Unit Handling

Milker Unit Attachment
The milker unit should be *attached within 1.5 to 2.0 minutes after initiating stimulation* to take maximum advantage of milk letdown. Excess air admission should be minimized to reduce agitation of the milk and mastitis risks.

Milking Unit Adjustment
Be sure that the milking clusters are properly aligned. Support and adjust teat clusters during milking if needed to assure proper milkout and minimize chances for air admission and liner squawks.

Omit Machine Stripping
Although many operators feel it is essential to get every last drop of milk by massaging or stripping, this step has more potential risks than benefits. Machine stripping increases liner slips. Cows become trained to need this, and it reduces milker efficiency.

Milking Unit Removal or Detaching
While most milking parlor today have ATO (automatic takeoffs), some still require manual vacuum removal. In that circumstance shut off the vacuum and allow teat cups to gently fall off after milk flow slows or stops. Pulling teat cups off under vacuum injures the teat and is the single greatest risk of machine induced mastitis spread.

Post Milking Teat Sanitation

Teats should be dipped as soon as is reasonably possible after unit removal with a safe, proven teat dip with an effective germicide. The entire teat should be covered on all sides to kill any bacteria in the film of milk where the unit was attached. Teat dip cups should be cleaned routinely.

Milking Order

Clean, uninfected cows should be milked first, and mastitis problem cows last to minimize risks of mastitis spread. It is essential to concentrate on proper milking practices and no other chores at milking time. A milking routine should allow each task to be performed timely, properly, and consistently. In tie stall barns those milking should not use more units than they can handle, especially when it compromises milking practices. If milking time exceeds 5 to 7 minutes per cow, evaluate milking practices and equipment. Milking time per cow also is influenced by milk production level, frequency of milking and level of mechanization.

$$\frac{\text{\# units X total milking time}}{\text{\# of cows}} = \text{milking time per cow}$$

Milking Equipment

The milking machine has three basic functions: 1) to create a controlled vacuum at the teat end to open the teat orifice and 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 first function is to move and regulate air. Air must be removed mechanically from the system to create low air pressure (less than atmospheric pressure) or vacuum. This vacuum must be regulated to provide a controlled 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 (cow-milk letdown) to a low pressure area. The goal is to milk the cow at the greatest pressure differential between the cow and machine but not injure the cow's teats. This maximizes milk flow and minimizes injury or mastitis. Recommended vacuum levels at the teat end under heavy milk flow are 11.5 to 12.5 inches. The system vacuum will depend on the type of barn and normal milk flow experienced. Blood, lymph and milk are drawn to the teat end so it will become congested unless a controlled intermittent massage or pulsation takes place (figure 7).

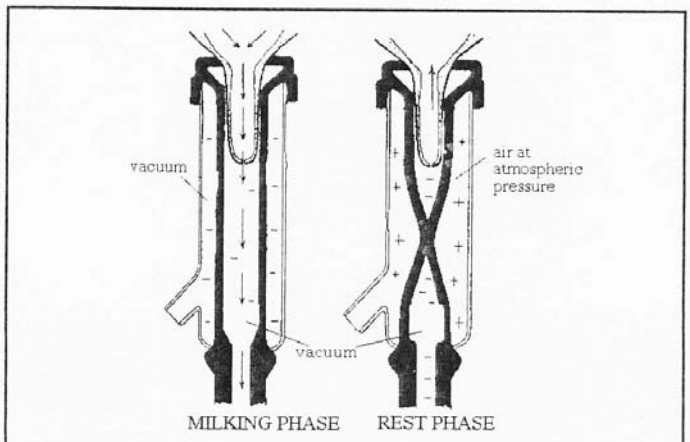


Figure 7. Milking and Rest Phases of Milking.

The milking system affects mastitis three ways. 1) Inadvertent air into the teat cup (squawk or slip) creates a reverse pressure gradient to move milk and potentially bacteria back at the teat. This is the primary way the machine affects mastitis spread. 2) Inadequate massage may injure teat ends and increase mastitis chances. 3) Poor milkout due to designs or restrictions in air and/or milk flow reduces teat end vacuum levels below recommended, resulting in slower milkout, poorer milk harvest, and extra milk left in the gland to fuel mastitis organisms.

There are four essential units to a milking system: 1) vacuum supply system; 2) pulsation system; 3) milk flow system; and 4) milking unit.

The *vacuum supply system* is responsible for creating, distributing and regulating vacuum. The vacuum pump is a mechanical device that extracts and exhausts air from the system to create the vacuum. They are rated by the cubic feet per minute or CFM of air they can move. The amount of CFM needed in a system depends on the number of milker units and operators. A series of pipes or lines are needed to distribute the vacuum to the milking and pulsation systems. These lines should be properly sized according to the amount of air or CFM being moved through them.

Lines should be as short and direct as possible to minimize turbulence and airflow restriction. Lines should be sloped properly for air movement and drainage (at least 1 inch per 10 feet of line). A vacuum gauge should be on the line and should be evaluated daily before, during, and after milking to assure stable vacuum is occurring. The gauge should be checked and calibrated at least annually. A regulator or vacuum controller is a vacuum limiting valve or diaphragm that prevents vacuum from exceeding a set value by admitting atmospheric air as necessary. This is the system's brain, as it must sense all air going in and out and continually adjust for the difference. It is vital to have a sensitive regulator, install it in the proper place, and clean it routinely since a lot of air and/or dirt and debris go through it.

The *pulsation system* consists of pulsators and long and short air hoses. 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 shell, causing the liner to collapse and massage the teat. It then removes this air by opening a port into the vacuum system. Pulsators have many small parts and areas to trap debris so they should be cleaned routinely. Air hoses should have no cracks and should be changed annually. Pulsators should be evaluated and graphed at least annually by a certified service person with the proper electronic equipment.

The *milk flow system* conveys milk and air from the milking unit to a collection vessel or receiver where the milk and air are separated. Milk lines should be properly sized dependent on number of units per line and milk production per cow in those units. Proper line slope is essential (1 inch per 10 feet minimum) since milk moves in these lines primarily by gravity, not vacuum. Leaks in lines or joints should be eliminated since air leaks cause turbulence, which can affect milk flavor, as well as cause air and milk flow restrictions.

The *milking unit* is the part of the machine that is suspended from the cow, performs the milking operation, and receives the milk. It includes the teat cup assembly (shell and inflations), claw, and connecting milk hoses. Components should be sized to maximize milkflow from the cow. Hoses should be as short and straight as possible to minimize air and milk flow restrictions. Inflations are the only piece to touch the cow and undergo shape changes every pulsation. It is imperative to change inflations at their recommended time or mastitis risks increase due to poorer milkout and an increased chance to harbor bacteria in cracks.

Air bleed holes in the inflations or claw (should only be in 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. Don't make the holes too big as excess air will only cause milk agitation, slow milkout, and increase mastitis risks.

Proper and routine maintenance is essential to keep the system functioning properly. Surveys of dairy farms that consistently produce high quality milk show the importance regular machine testing and servicing by qualified technicians. Cleaning and sanitizing the system after each milking improves milk quality by lowering bacteria counts and mastitis risks. The milking system is like a ventilation system in that air is mechanically removed to create vacuum or low pressure, then inlets are placed to allow in high pressure things. Routine cleaning and maintenance of all inlets and outlets is crucial. Vacuum pumps should always have oil if used, tight belts, and be in a clean place. These should be checked daily or weekly.

Pulsators, bleed holes, and regulators (air inlets) should be cleaned routinely when inflations are changed or at least every six months. Inflations (high pressure milk inlet) should be changed routinely according to the material and brand used. All hoses should be replaced annually and the milking system should be evaluated by a certified service person at least annually to evaluate pump, regulator, and vacuum system

performance; pulsators; and milking time performance. It is crucial to analyze the system during milking to evaluate the capacity of the system to handle the milk flow of the cows and herd.

Robotic Milking Systems

Robotic milking systems, also called automatic milking systems or voluntary milking systems, completely automate the milking process. This system allows the cow to decide its own milking time and interval, rather than being milked as part of a group at set milking times. Milking robots can serve 50 to 60 cows each. Cows will, on average, visit the robot and get milked 2 to 3 times per day.

The robotic milking system contains a milking machine, a teat position sensor, a robotic arm for automatic teat-cup application and removal, and a gate system for controlling cow traffic. When the cow enters the milking unit a cow ID sensor reads an identification tag on the cow and passes the cow ID to the control system. If the cow has been milked too recently, the automatic gate system sends the cow out the unit. If the cow may be milked, automatic teat cleaning, milking cup application, milking, and teat dipping takes place. As an incentive to attend the milking unit, concentrated feedstuffs is fed to the cow inside the milking stall and can be adjusted to the production level of the individual cow.

Detection of abnormal milk is done with machine sensors instead of the human eye. Unlike traditional milk quality measurements that are the average of the entire udder and tested monthly, robotic milking systems monitor milk quality measurements by the quarter for every milking during the day. Sensors have the capability of measuring milk conductivity, milk color, fat, protein, and even somatic cell count.

Mastitis

Mastitis is inflammation of the mammary gland that results from the animal responding to udder injury or irritation.

The primary cause for this inflammation or mastitis is bacteria that gained entrance to the gland through the streak canal. One of the cow's primary responses to mammary infection is to mobilize white blood cells or somatic cells from her blood stream to the infected quarter(s) of the gland. Somatic cells play a major role in engulfing and destroying bacteria and are instrumental in repairing mammary gland tissue.

Mastitis is the most costly dairy cattle disease with cost estimates ranging from $100 to $250 per cow per year in herds with good and poor hygiene and milking practices, respectively. These costs would include treatment costs (products, time, management), veterinary services, death loss, early culling, discarded milk, and lost milk production, which can be short term or permanent depending on the organism, severity, and duration of infection.

Lost milk production potential accounts for 50 to 80% of economic losses due to mastitis. Mastitis also effects product quality and processing characteristics and costs. Many processors pay quality premiums for low SCC milk. This also represents additional lost income when mastitis is a problem.

Degrees of Mastitis

Subclinical or hidden mastitis is when there are no visible changes to the milk, udder, or cow. This type of mastitis accounts for 70 percent of all mastitis losses and can be detected with DHIA testing or cowside milk SCC detectors. Clinical mastitis is characterized by visual changes in the milk, udder, or cow. These changes can range from mild clots or flakes, to an acute mastitis where there is massive swelling, fever, appetite depression, and occasionally death due to toxemia. Clinical mastitis is classified into 3 categories: Mild – abnormal milk, Moderate – abnormal milk plus swelling, Severe – abnormal milk, swelling and systemic signs of illness i.e. fever. Chronic mastitis is a persistent infection. It is mainly subclinical but can occasionally develop an active clinical case.

When Infections Occur

About one-half of all mastitis infections occur during lactation, with most occurring in the first two months of lactation. The other half are contracted during the dry period. The first and last two weeks of the dry period also have high incidence of mastitis. Reasons for increased susceptibility include 1) flushing effect of milking is terminated; 2) open teat canals and/or increased mammary pressure resulting in distension and potential leakage; and 3) immunological factors are low, suppressed or preoccupied with milk component removal. In contrast, the fully involuted gland during the middle of the dry period is highly resistant to infections due to a thick keratin plug in the streak canal and enhanced immunological factors (figure 8).

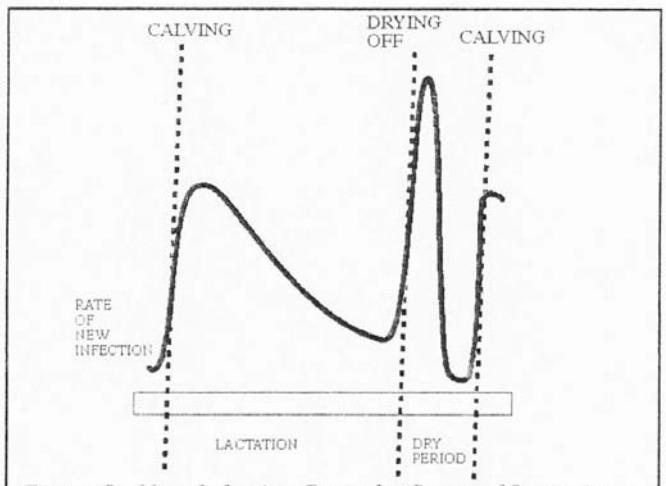


Figure 8. New Infection Rates by Stage of Lactation.

Identify Causative Organisms

There are many different types and strains of organisms that have been implicated in mastitis. However there are a few organisms or groups of organisms which comprise more than 95 percent of all mastitis. There are a group of organisms that are contagious. This means the primary source for spreading is milk from an infected animal and the primary time for spread

is at milking time. Streptococcus agalactiae and Staphylococcus aureus are contagious mastitis organisms that result in chronic high cell counts but mainly subclinical mastitis. Mycoplasma bovis is also contagious but is associated with clinical mastitis in multiple quarters.

Environmental mastitis organisms like Streptococcus species and coliforms (E. coli, Klebsiella) are not contagious with the primary source of infection being the cow environment and many infections contracted between milkings and during the dry period. Environmental mastitis is usually associated with clinical mastitis signs and is short duration. To properly identify organisms, teat ends should be cleaned and disinfected with alcohol and a milk sample collected into a sterile container for submission to an appropriate diagnostic lab.

Mastitis Monitoring

Clinical mastitis cases are easy to recognize and monitor by proper evaluation of milk during the milking process and casual observation of animals in their environment. Special tests are necessary to diagnose and monitor subclinical mastitis. Monitoring somatic cell counts is the easiest, most economical approach since bulk tank SCC is monitored routinely by the milk processor, and individual cows monitored monthly by dairy producers on a DHIA testing program. Somatic cells are a response to infection in the gland, so elevated levels indicate mastitis. Herd or individual cow SCC greater than 100,000 cells per ml indicate that a mastitis problem likely exists. The two most critical SCC pieces to monitor are the number of high SCC or problem cows and the number of those that are new infections or new high SCC cows. New infections indicate current problems and weakness in mastitis management that need evaluation and attention. Different herd summaries can help pinpoint problem areas (old vs. young cows, early vs. middle vs. late lactation). Other uses for individual cow SCC include establishing a milking order, evaluating treatment efficacy, identifying cows for culling, and identifying healthy cows for purchase. There are also some tests like the California Mastitis Test (CMT) that can be used cowside to evaluate individual quarter SCC. Although this is a subjective test, it can be performed easily, rapidly, and inexpensively.

Mastitis Control Programs

Prevention

The primary goal or objective is to prevent mastitis by minimizing bacterial exposure to the teat end 24 hours per day and maximizing factors such as nutrition that make for enhanced immunity. Key areas for control are:

1) *Nutrition* - Proper, well balanced nutrition is essential to not only provide nutrients for milk but also to maximize health and immunity. Also, the practice of supplying fresh feed after milking keeps cows standing while teat ends close up.

2) *Proper milking practices and equipment* - These provide optimal milkout while minimizing mastitis risks.

3) *Environment* - This is a key area since most of the cows' time should be spent resting or lying down. The key is to provide areas that are clean, dry and comfortable. Cow comfort is important to entice a cow to that area as well as improve immunity through better feed and nutrient utilization. Clean and dry are key to minimizing mastitis organism growth.

Treatment

Treatment is an integral part of mastitis control but is listed last because it can't substitute for prevention and is often necessary due to failure in prevention. All treatment should be carefully evaluated before being implemented.

The ideal time to treat mastitis organisms is after the last milking before drying off. Dry treatment has several advantages including the ability to use higher, more persistent doses of antibiotic while minimizing residue risks since the animal is out of the milk string. This results in higher cure rates at this time. Dry treatment also provides some protection against certain organisms during the early dry period. Dry treatment, however, provides little or no protection during the late dry period and is no substitute for late dry period and calving area sanitation. Current recommendation is to dry treat all quarters of all cows.

Although prevention is the goal, occasionally a breakdown occurs and a decision to treat a lactating cow is faced. Although there are risks, an organized treatment and residue prevention protocol can maximize treatment benefits while minimizing residue risks. Keys to this are

1) Provide the best animal care possible to maximize the cow's own immune system.
2) Work closely with a veterinarian to establish proper treatment guidelines and protocols.

3) Always use safe, approved, effective antibiotics that are properly labeled and stored.

4) Read labels carefully before treatment and administer the proper dose in the proper manner.

5) Mark treated cows with proper visual identification so that all farm employees know that animal is treated.

6) Record the treatment in a place where all employees can see and have access to, as well as in a permanent cow record.

7) Communicate the treatment to all employees and farm personnel.

8) Milk treated cows last or in a separate string to minimize residue risks.

9) Discard all milk from treated cows.

10) Test the milk through your processor or use an on-farm antibiotic tester to assure milk is cleared of antibiotic or other products before returning that cows milk to the tank.

11) Follow and adhere to proper withdrawal times.

Milk Quality Assurance

Milk quality must be excellent when leaving the cow since this quality can only be maintained and not improved at the farm or the rest of the product chain. Producing quality milk is a continual process every day. Proper genetic selection and nutrition provide for excellent, nutritious milk components like protein, lactose, fat, vitamins, and minerals. Also proper feeding enhances animal health and maximizes milk flavor. Proper milking techniques and equipment coupled to a clean, dry, comfortable, environment assure maximum milk quality and quantity while enhancing animal health and minimizing mastitis risks. These assure milk with the lowest bacteria and somatic cell counts, as well as excellent taste and shelf life due to proper, gentle handling and refrigeration.

A well-planned and managed treatment and residue avoidance program working with a veterinarian assures safe, residue free milk and dairy products. Sum it all up and the results are safe, nutritious, high quality, consistent dairy products for all consumers.

The Milk Plant

Where does our nation's milk supply come from? Many consumers realize milk is produced on dairy farms. But do consumers realize the many processes milk goes through to ensure a healthy, nutritious product?

There are many steps of fluid milk processing. An important part of this process is testing and regulating the milk supply. Milk and dairy products are among the most strictly regulated foods, because they are very perishable. Also, milk must be a safe, disease-free food because many people, especially children, drink milk every day as a source of calcium, protein and other necessary nutrients.

The Food and Drug Administration (FDA) and the US Department of Agriculture (USDA) are the federal regulatory agencies involved in dairy processing. The department of agriculture in most states enforce processing regulations and inspects dairy plants and dairy farms for cleanliness of facilities and proper handling of raw, or unprocessed milk. Grade A milk plants are inspected a minimum of every 3 months, and manufacturing grade (Grade B) plants are inspected every 6 months.

Grade A milk and milk products are regulated under the "Grade A Pasteurized Milk Ordinance" (PMO) and manufacturing grade milk is regulated under the USDA Guideline "Recommended Requirements for Milk for Manufacturing Purposes". Grade A products include all fluid milk products, yogurt, buttermilk and dairy products that are labeled as Grade A. Manufacturing grade products include butter, cheese, ice cream, and other products.

When milk haulers pick up the milk on the farms, they collect a sample from each bulk tank. These samples can be tested for antibiotic residues, bacteria and somatic cell counts. Milk from several farms will be transported to a milk plant in a large milk transport tank.

Every bulk milk transport tank is screened (tested) for antibiotic residues before it is unloaded at the plant. If the load is found positive for antibiotics, the load is declared unfit for human consumption and is normally either dumped in a manure lagoon or field spread. Each producer sample from that load of milk is then tested for antibiotics, and the producer(s) with a positive sample are held responsible for contaminating the load of milk.

Most fluid milk dairy plants also test for quality and require bulk milk temperatures to be lower than the 45°F legal maximum. Low temperatures and testing of milk assures a safe, wholesome product for the consumer.

After the milk is properly tested, the milk is stored for a short time in large refrigerated tanks at the plant. Fluid milk processing starts with standardization, an adjustment of the milk fat percentage to meet state and plant standards. Plants use a separator to separate the milk into cream and skim milk and then add skim milk to reduce fat percentages that are too high, and add cream to increase milk fat percentages.

Fat percentages are regulated by the "Code of Federal Regulations" (CFR) which state what the butterfat content must be in order to comply with the labeling of the product. Pasteurized whole milk has a minimum of 3.15 percent milk fat content. Lowfat milk contains 0.5 percent to 2.0 percent milk fat, while skim milk must have less than 0.5 percent milk fat. Lowfat and skim milk have become more popular drinks in recent years, as consumers have reduced the amount of fat in their diet.

Milk is also clarified to remove foreign sediment. This process uses centifugal force, or rapid spinning of the milk.

Pasteurization is a very important part of milk processing. This step destroys any disease-causing bacteria by heating every particle of the milk. Most dairies use the high-temperature, short-time (HTST) process for pasteurization. The HTST must heat milk to a minimum of 161°F (71.5° C) for a minimum of 15 seconds. Every 3 months Grade A fluid milk HTST systems are tested by the state inspector for temperature, holding time, and other safety requirements as required in the PMO.

Pasteurized milk can be kept for 10 to 14 days under refrigeration, however, since most bottling plants accept only the highest quality raw milk and heat milk to over 170°F for over 20 seconds, milk can be kept fresh for over 20 days under refrigeration.

Technology now allows us to pasteurize milk through ultra-high temperature (UHT) processing. The process heats milk to 280°F (138° C) for two seconds. UHT processed milk can be stored for at least three months without spoiling. When UHT milk is processed aseptically, in a sterile environment, it can be stored at room temperature and stored for up to 6 months. Once the package is opened, however, the milk must be refrigerated.

During the HTST process, the milk is also homogenized to reduce milk fat particles. Pressure is used to squeeze the milk through tiny valves so that the milk fat no longer separates from the rest of the milk.

Pasteurized and UHT milk is immediately cooled to 45°F after heating. The ideal temperature for milk to stay fresh is below 38°F at the plant, the distributor, the store and in the consumers refrigerator.

Processed milk is fortified with vitamin D. Lowfat and skim milk is also fortified with vitamin A. Vitamin A is found naturally in milkfat and does not need to be added to whole milk.

Finally, milk is ready to be packaged in plastic jugs, paper cartons, glass bottles or plastic bags. The milk is delivered to stores and restaurants, ready for consumers to enjoy.

PASTEURIZATION: The terms "pasteurization", "pasteurized" and similar terms shall mean the process of heating every particle of milk or milk product, in properly designed and operated equipment, to one (1) of the temperatures given in the following chart and held continuously at or above that temperature for at least the corresponding specified time:

Temperature	Time
63ºC (145ºF)*	30 minutes
72ºC (161ºF)*	15 seconds
89ºC (191ºF)	1.0 second
90ºC (194ºF)	0.5 seconds
94ºC (201ºF)	0.1 seconds
96ºC (204ºF)	0.05 seconds
100ºC (212ºF)	0.01 seconds

*If the fat content of the milk product is ten percent (10%) or greater, or a total solids of 18% or greater, or if it contains added sweeteners, the specified temperature shall be increased by 3ºC (5ºF).

Figure 1. Fluid Milk Processing

PRODUCE Milk produced on dairy farm
TRANSPORT Milk hauled to plant in refrigerated truck
SCREEN All milk tankers are tested for antibiotics
STANDARDIZE Milk mixed to meet uniform fat standard
CLARIFY Remove sediment from milk
PASTEURIZE High temperatures kill disease-causing bacteria
HOMOGENIZE Milk fat particles broken down
FORTIFY Vitamin D and other nutrients added
PACKAGE Milk put in plastic jugs, bags or cartons
DISTRIBUTE Milk sent to grocery stores or restaurants

Grades of Milk

Raw milk is designated as a Grade A or Grade B product. About 94 percent of all milk produced nationwide is sold as Grade A. This grade is the only milk that may be used for fluid milk products. All Grade B milk must be used to make manufactured dairy products, such as butter, cheese or powder.

Some Grade A milk also is used to make manufactured products. This is because a lot of milk is needed to make dairy products and there is more Grade A milk available than what is needed for Grade A processing.

Additionally, consumer demand for cheese, yogurt and other products has increased significantly over the past two decades.

Less than 30 percent of the nation's milk supply is sold as fluid milk and cream. Over 40 percent of the nation's milk is processed into cheese, while the remaining 30 percent is utilized for butter, ice cream and other dairy products. The following chart shows the pounds of milk required to make one pound of various dairy products.

Table 1. Pounds of Milk Needed to Make Different Dairy Products

Product	Pounds of Milk Used
Butter	21.2 lb whole milk
Whole milk cheese	10.0 lb whole milk
Evaporated milk	2.1 lb whole milk
Condensed milk	2.3 lb whole milk
Whole milk powder	7.4 lb whole milk
Powdered cream	13.5 lb whole milk
Ice cream (one gallon)	15.0 lb whole milk
Cottage cheese	6.25 lb skim milk
Nonfat dry milk	11.0 lb skim milk

Milk Pricing

When a consumer reaches into the supermarket dairy case for a carton of milk, it's the last step in a long process that began on a dairy farm. When that carton of milk goes through the supermarket checkout, a lot of things have happened to determine the price rung up on the cash register.

Because milk production is a natural process of the dairy cow, the supply cannot be turned off and on to keep pace with demand. Production fluctuates seasonally but demand remains fairly constant.

Additionally, some areas of the country do not have enough milk produced to meet the demand of consumers, and other regions produce more milk than the people in that area will buy.

Prices and production levels must be adjusted to satisfy everyone. The public must receive the milk it wants at a reasonable price. The processors must obtain enough milk to make dairy products. And the dairy farmers must receive the return they need to stay in business.

Because milk production needs to be stabilized and regulated, Federal Milk Marketing Orders (FMMO) were established by USDA. These orders set minimum prices processors must pay dairy farmers for raw, fluid-grade milk. FMMOs are divided by geographical regions.

Under the Federal Order system, milk is priced according to a classified plan. Prices are set according to how the milk will be used. Milk is classified according to these uses:

Class I: Fluid milk products, including cream and buttermilk

Class II: "Soft" manufactured products, such as sour cream, yogurt and ice cream

Class III: "Hard" manufactured products, including cheese and cream cheese

Class IV: Butter and dried milk powder

Only Grade A milk may be used for Class I and Class II products. Both Grade A and B milk is used for Class III and IV products.

The value of milk, regardless of its use in products, must be fairly distributed to all dairy producers in a geographic area. Also, processors must be certain there is enough milk to meet demands for fluid milk and manufactured products in the region. Therefore, a complex milk pricing system has been established.

The price dairy farmers receive for milk is the result of this complex system. The value of the milk in the region is pooled, and farmers are paid an average price for all four classes. Producers in Minnesota are paid based on component pricing (see section below) in addition to quality and other premiums.

Producers of Grade A milk generally receive a higher price than producers of Grade B milk. This is because Grade A milk can be used for fluid milk and has a higher value than Grade B milk used for manufactured dairy products.

Other adjustments are made to the producer price. These adjustments vary from farm to farm. Here are some common adjustment factors:

1) geographic region in which milk is produced

2) the composition of milk sold (butterfat, protein and other solids percentages)

3) the quality of milk sold (somatic cell and bacteria counts)

4) hauling fees

5) assessments paid to milk marketing organizations

6) regulatory assessments

Processors and retailers influence the price of milk in grocery stores. They add costs for processing, handling and selling the products.

Dairy Cooperatives

Over 80 percent of milk produced in the United States is sold through dairy cooperatives, which market milk for their members as a group.

A cooperative is a business owned and controlled by its member patrons. Patrons often receive additional benefits, like milk testing, from the cooperative. The cooperative's earnings are returned to the member patrons each year.

Component Pricing

Component pricing bases milk prices on the quantity or percent of various milk components, such as fat, protein and solids-not-fat (SNF). Historically, milk has been priced on a single component, butterfat. Thus, farmers have benefited from higher levels of butterfat in milk they produce.

In recent years, consumers have reduced fat in their diet, making butterfat a less valuable component. Protein and other nutrients have become more important. In many regions of the country, multiple component pricing has been implemented or discussed. This system provides an economic incentive for farmers to produce what the consumer demands, increased protein, and other solids.

Milk Pricing Terms

The following terms are part of the complex milk pricing system. If you have more questions about milk pricing, contact your milk marketing representative or county extension agent.

Federal Milk Marketing Order: A regulation issued by the Secretary of Agriculture that puts certain requirements on the marketing of milk in a particular geographic area.

Handler: A milk processor or distributor

Classified Price System: The use of a schedule of prices that handlers pay for milk, depending on whether it is used for fluid milk or manufactured products

Component pricing: Pricing milk based on the quantity of components including butterfat, protein and solids-non-fat in milk. All milk in Minnesota is component priced.

Blend Price: The price handlers pay producers for Grade A milk weighted in the Classified Price System

Milk and Dairy Products

Milk - Nature's Most Nearly Perfect Food

Milk and the products made from it have played an important role in the health of Americans since Christopher Columbus made his second voyage to America in 1493, bringing dairy cattle with him. He didn't do so the first time and the lack of milk was said to have contributed to the high death rate during the voyage, particularly among young cabin boys. Dairy cows and other animals were required to be brought on all subsequent voyages.

Since 1611, when cows were part of the settlement at Jamestown, a steady milk supply and the availability of everyone to obtain fresh and wholesome milk products has been taken for granted. However, that wasn't always the case. Many advancements and improvements in all parts of the industry – from farms to processors to wholesalers, retailers and foodservice – have brought milk's availability and value to where it is today.

Nine Essential Nutrients

Milk is one of the most valuable of all foods and is nutrient-rich. Milk, cheese and yogurt have a unique nutrient package that contains nine essential nutrients. These nutrients are calcium, potassium, phosphorus, protein, vitamins A, D and B12, riboflavin and niacin (niacin equivalents).

Calcium
Calcium helps build and maintain strong bones and teeth. This mineral also plays an important role in nerve function, muscle contraction and blood clotting.

Potassium
Milk and yogurt contain as much potassium as a banana. Potassium helps regulate the body's fluid balance and helps maintain normal blood pressure. It's also needed for muscle activity and contraction.

Phosphorus
Phosphorus helps strengthen bones and helps generate energy in the body's cells.

Protein
Dairy is an excellent of high quality protein. Protein supports the growth and repair of muscle and other body tissues. Casein, a protein found only in milk, contains all of the essential amino acids. Consuming protein in the recommended amounts, as part of a balanced diet containing adequate calcium and vitamin D, also helps build and maintain bone.

Vitamin D
Vitamin D, also known as the sunshine vitamin, helps promote the absorption of calcium and helps strengthen bones. It is the key that unlocks the door in order for calcium to be absorbed. Vitamin D also helps maintain adequate blood levels of calcium and phosphorus. . Milk is one of the few dietary sources of vitamin D. One 8-ounce glass provides 25% of your daily requirement.

Vitamin A
Vitamin A helps maintain normal vision and skin and is also important for bone growth. It also helps regulate cell growth and helps maintain the integrity of the immune system.

Vitamin B12
Vitamin B12 helps maintain healthy nerve cells and red blood cells, and is also needed to make DNA.

Riboflavin
Riboflavin or vitamin B2 helps convert food nutrients, such as protein, fat, carbohydrates and alcohol into energy the body can use. It is also important for normal eyesight and healthy skin.

Niacin (as niacin equivalents)
Niacin is important for the normal function of many enzymes in the body and is involved in the metabolism of sugars and fatty acids.

There is absolutely no waste in milk use. Every part of this delicious food can be enjoyed and easily digested by almost everyone. Few other foods qualify for that statement. The quality and taste appeal is hard to beat.

Keeping Milk and Dairy Products Fresh and Wholesome

Milk tastes best when it's served icy cold and fresh tasting — between 35° and 40°F. When kept properly cooled, milk should last 2-3 days beyond the 'sell by' date written on its container. Most fluid milk travels less than 100 miles from the farm to the grocery store, and arrives in the dairy case in less than two days. Both farmers and processors must follow strict regulations on keeping milk cold from the moment it comes from the cow. In addition, milk is routinely sampled by regulatory authorities to make certain that it is wholesome, and all milk is tested to be certain it is free from antibiotics. Any milk testing positive is destroyed and never reaches the consumer.

Milk is pasteurized to assure that any bacteria present are not in the final product. Pasteurization involves the heating of raw milk to a minimum of 145° F for 30 minutes or to 161° F or more for 15 seconds, followed by rapid cooling. This step is very important in continuing the production of safe milk. Research has shown that there is no significant difference in the nutritional value of pasteurized and unpasteurized milk. In a recent report, the U.S. Food and Drug Administration and the Centers for Disease Control Prevention reminded consumers that even with sanitary collection practices, raw (unpasteurized) milk could contain harmful bacteria. Federal law prohibits the retail sale of raw milk across state lines and many states have banned the sale of raw milk.

Cheese, Please

More than 40% of all milk produced each year in the U.S. is used to manufacture cheese. More than 10 billion pounds of cheese are made each year, and there are more than 300 varieties of cheese made in the U.S.

Because it contains nearly all of the same nutrients as milk, cheese is also a highly nutritious food. Many cheeses are classified as excellent sources of calcium and good sources of phosphorus and protein. In fact, cheese is the fourth largest protein source for adults. The proteins in many cheeses are also readily digestible, because they begin to break down during ripening of the cheese. One serving is 1½ ounces.

Cheese is made by coagulating the milk with rennet or a bacterial culture or both. Then, the curd is separated from the whey by heating, draining and pressing. Each pound of cheese uses about 10 pounds of milk. Cheeses are different because of the kind of milk and other ingredients used, the methods for making and aging it, the type of culture used and the way it is salted.

Ancient legend has it that cheese was first made accidentally by an Arabian merchant who put his milk into a pouch made from a sheep's stomach, then set out on a journey. The rennet in the lining of the pouch, combined with the sun, caused the milk to separate into curd and whey, both of which satisfied his hunger. The Pilgrims included cheese in the Mayflower's supplies when they came to America in 1620, and the first cheese factory in the U.S. was built in New York in 1851.

Yogurt Comes of Age

Yogurt is the result of culturing a mixture of milk and cream products with lactic acid-producing bacteria. It first appeared in the U.S. in 1940, but its growth has been exponential in recent years. Most yogurts provide an excellent source of calcium, phosphorus and riboflavin, and are a good source of protein and potassium.

We All Scream for Ice Cream

Ice cream is a fun food, and while it's not one of the primary products to deliver nutrients, it is a wholesome, delicious and convenient treat or dessert. Ice cream's origins are known to reach back as far as the second century B.C., but the first account of ice cream in the New World comes from a letter written in 1700.

It takes about 15 pounds of whole milk to make a gallon of ice cream. While every manufacturer develops its own recipe, the most important ingredients come from milk, and in order for a product to be called ice cream, it must be at least 10% milkfat. Similar products below that amount may be called by other names such as soft-serve.

Chocolate Milk as a Sports Refuel Beverage

Research has found that chocolate milk is almost twice as effective as commercial sports drinks to refuel exhausted muscles. Low-fat and fat-free milk – white or chocolate – offer a more nutrient-rich alternative in a relatively inexpensive way. Every serving provides nine essential nutrients which help the body to function properly and perform at its best. Carbohydrates refuel muscles, protein reduces muscle breakdown and stimulates muscle growth, and fluid and electrolytes replenish what is lost in sweat to rehydrate the body. Calcium and vitamin D work together to build strong bones.

Dairy Product Consumption

MyPyramid, USDA's interactive Food Guidance System, shows the nutrient-dense super foods that Americans should consume on a daily basis — and includes 3 servings of low-fat and fat-free milk, cheese or yogurt for those ages 9 and older. Recommendations for children ages 2-8 are for a total of 2 cups. Research shows children who drink milk have higher intakes of specific nutrients and are better nourished than children who don't. In fact, milk, cheese and yogurt deliver four of the seven nutrients people miss most in their diet – calcium, potassium, magnesium and vitamin A.

Yet, most Americans don't even come close to getting the recommended amount of dairy in their diet. On average, Americans are getting only about half the servings of dairy they should consume. Still, dairy product consumption has gone up in the past 25 years. While per capita consumption of dairy products stood at 522 pounds in 1983, by 2010 it had rebounded to about 611 pounds per capita, led by increased intake of cheese.

Table 1.
Descriptions of the most common dairy products.

2% milk - milk that is 2 percent butterfat

blue cheese - smooth, soft-textured cheese made using a surface mold; light-colored with blue lumps

butter - made through a churning action with cream that results when the fat droplets come together to form larger and larger globules until they separate from the water part of the mixture; often sold in pound blocks or in sticks

buttermilk - the liquid formed when making butter

cheddar cheese - the most popular cheese consumed in the United States; dark yellow in color and aged for varying lengths of time; sold in mild or sharp varieties

cottage cheese - made by coagulating the milk proteins into curds and collecting them; this soft product often is the beginning step in the making hard cheese

cream - the type of milk with highest butterfat content; often used in making whipped products

custard - a desert product made by coagulating milk proteins through the application of heat; contains egg proteins that have been diluted with milk and sugar

egg nog - a holiday drink made from eggs and milk

feta cheese - cheese made from goat's milk

ice cream - desert made by adding sugar and eggs to cream and using a stirring motion to freeze the product so air is added, giving it a smooth texture; may include nuts or fruits

ice milk - a frozen dairy product similar to ice cream except that it does not contain as much fat

low-fat milk - milk that is 1 to 2 percent butterfat

mozzarella cheese - this type of cheese commonly is found on pizzas and is soft with a light color

raw milk - milk that is straight from the cow that has not been pasteurized or processed

Roquefort cheese - cheese made from sheep's milk

skim milk - milk that must be less than 1 percent butterfat

Swiss cheese - a light-colored cheese known for having characteristic holes or air pockets throughout

whipped cream - cream is whipped through mixing action and sugar is often added

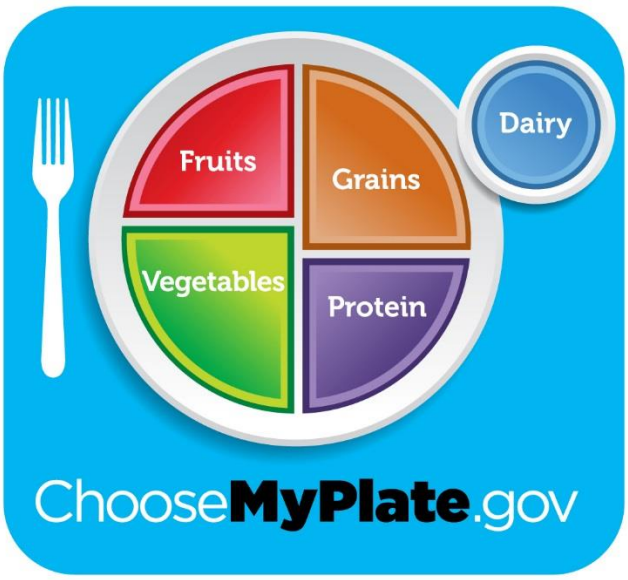
whole milk - milk that is 3.25 percent butterfat

yogurt - a cultured dairy product with a sour taste that is made by adding a starter (bacterial) culture; often flavored with fruit

Milk by the numbers

1 cup milk	Calories (Kcal)	Fat (g)	Calcium (mg)
Whole	149	7.7	291
2% Reduced fat	121	4.4	296
1% Lowfat	104	2.2	312
Nonfat	90	0.5	316
Chocolate, Whole	208	8.0	280
Chocolate, 2% Reduced fat	178	4.7	284
Chocolate, 1% Lowfat	157	2.3	286

Source: USDA Nutrient Database for Standard Reference.



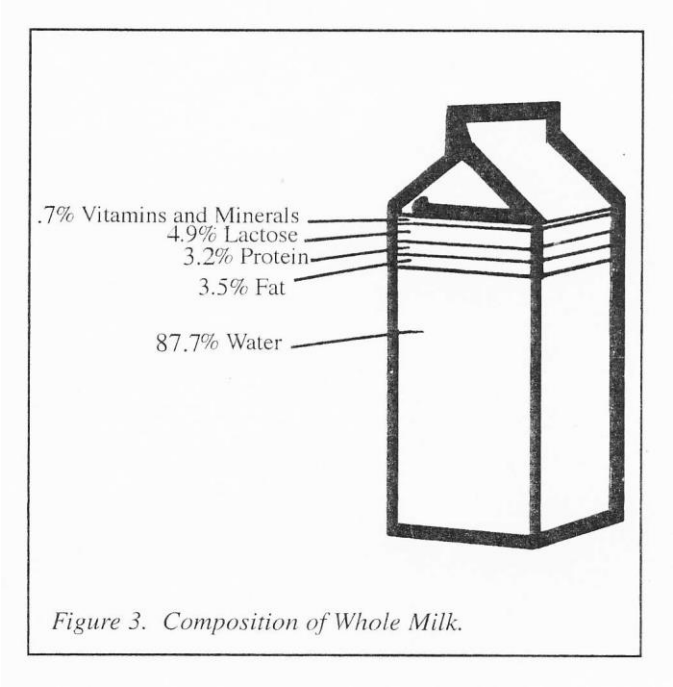


Figure 3. Composition of Whole Milk.

Resources to Learn More:

www.midwestdairy.com

www.dairyfarmingtoday.org

www.nationaldairycouncil.org

www.nutritionexplorations.com

www.usdairy.com

www.innovatewithdairy.com

www.nutritionexplorations.org

www.choosemyplate.gov

$$ Dollars and Dairying $$

As part of the 4-H Dairy program young people learn the application and use of sound business principles in the management of specific dairy projects. This section of the manual addresses some - but not all - of the business side of dairying.

In order for a dairy farm to be successful it must be operated as a business so it can be profitable. A dairy farm requires a great deal of capital in order to invest in the machinery, equipment, cattle, housing and feed storage needed to start up the business and then keep it going every day. Enough revenue must be generated from the sale of milk, and in some cases also from selling breeding stock where that is part of the business plan, in order to cover all the expenses incurred while operating the farm. The dairy producer must be able to cover the labor expense as well as receive a fair return on the investment in the business if it is to survive.

Records - A Must for Dairy Producers

Record keeping is an essential part of any successful business and is vital for sound decision-making. Good recordkeeping
can help improve farm efficiency and profitability by providing information to more accurately assess inputs and outputs, helping farmers to make better decisions that will lead to maximum profit.

Record keeping has long been a part of the 4-H program. Decisions about your project or a dairy operation should not be made by guess work. Record keeping is emphasized in the dairy project to help young people learn and understand how income is generated and how costs are distributed with an animal(s) which will provide experience and background if and when entering the dairy business. Records help keep track of information so when the dairy project is analyzed its profitability can be determined. If your 4-H dairy project is to be a success, you must keep and use records. If your dairy project leads into a dairy career, the ability to keep and use records will be required. Keeping good records in 4-H is also important since they are used to help select project award recipients.

While records do provide historical data and gives you the opportunity to analyze your project and business, they should be more useful in planning the future. Every good record system should be:

- used often
- kept current
- easily updated
- easily understood
- easily summarized

There are three steps in record keeping and information use:

1. Temporarily record information where the work is being done or where the observations are being made (heifer shed, calf barn, milkhouse, parlor, free-stall barn, palpation rail) using a notepad, blackboard, or a hand held electronic device.
2. Transfer the information to a permanent record (notebook, computer, DHI, etc.).
3. Process, summarize, analyze and disseminate the information

Records can be kept simple and recorded in a farm recordkeeping book. Or, records can be more elaborate and/or detailed. The complexity of the farm business has increased the need for computers to help keep track of costs, to track herd and individual cow production and performance, to produce reports to identify areas that need improvement and to better manage the farm finances. A wide variety of dairy-related software programs are available. Before purchasing a software program, it is important to determine if it fits your needs, tracks the information you feel is important and generates the reports that will be useful to you.

The six major areas of dairy records needed are:

- Animal Identification
- Feeds and Feeding
- Health
- Reproduction
- Production
- Economics

Following is a short discussion of each of the six areas. There is information in other parts of this resource guide that can be used with this section of the manual. County and regional extension educators and state extension specialists will likely have additional reference material
.

1. Animal Identification

The identification of animals on the dairy farm is important in order to keep accurate records of each animal's health, care, management and performance. On dairy farms with large numbers, it can easily become difficult to identify specific animals. On dairy farms where there are strong family breeding lines, properly identifying each animal helps track characteristics that can be passed down through genetics.

In 2007, the U.S. Department of Agriculture's National Animal Health Monitoring System (NAHMS) conducted the "Dairy 2007" study. The study collected data on dairy health and management practices from 17 of the nation's major dairy states. These states represented 79.5 percent of U.S. dairy operations and 82.5 percent of U.S. dairy cows. The study found:

- Almost all cows (97.4 percent) had some form of individual ID.
- Ear tags were the primary method of individual animal ID (94.0 percent of cows on 86.5 percent of operations) followed by branding (13.2 percent of cows on 4.4 percent of operations) and collars (0.3 percent of cows on 12.7 percent of operations).
- Electronic ID was used for 9.0 percent of cows and on only 4.1 percent of operations.
- On operations that used individual animal ID, evaluating milk production was the primary reason for using animal ID on 38.1 percent of operations, and evaluating genetic improvements was the primary reason on 30.4 percent of operations.
- One of the most important benefits of using ear tags is they can be personalized to show both a number to represent the farm and an individual animal number. Identification tags make treating and recording the treatments of those individual animals a lot quicker as well.

Electronic Identification methods are beginning to be used on more farms. These include bar codes and/or radio frequency identification (RFID) transponders which can be useful tools in herd management programs. When considering the use of electronic ID technology, realize that the technology is still evolving. Therefore, take the time to research and study the technology to understand how it can benefit your dairy project.

Dairy Herd Improvement (DHI) records provide information for producers to use in improving the production efficiency of their herds. Minnesota DHIA reports contain pedigree and identification information on all heifers and adults in the herd including the animal ID, DHI control or computer number, registration number, DHI or USDA tag number, 8 Character note or 2nd ear tag number, sire ID number, sire registration number, dam ear tag or registration number, dam barn name, dam ID number, birth date, lactation number, string number, times bred, reproduction code, and age.

Individual identification records should include <u>at least</u> the following information:

- Birth date
- Parents
- Name, registration or grade identification number, DHI computer number
- Color markings (drawing or photo)
- Size and growth record (compare to standard growth curves)

Animal identification records should be kept in a safe, but handy, area. They also may be recorded with a breed association and/or DHIA. Each breed association may have different policies. Contact the appropriate breed association for current and complete information.

Some dairy shows allow only registered animals to be exhibited. Other shows allow identified grade animals. Check show regulations early to allow time for identification and registration, if necessary.

2. Feeds and Feeding

Feed is the largest single cost in producing milk, generally around 50-55 percent of the total cost. Therefore, it is important to keep complete and accurate feed records. A review of the feeding program should be made often to see if there are ways to reduce these costs. However, before changes are made the impact a change could have on other aspects of the overall operation must be taken into account. The lowest cost ration may not necessarily be the most profitable. Without records, it is difficult to determine where money can be saved and what impact the change will have. It's a good management practice to have a laboratory analyze the forages and other homegrown feed, then keep a record of those results to fine-tune your rations. Using records, milk production groups can be established to allow different rations to be formulated according to need, reducing total feed

cost. Records can also help determine which cows are profitable by checking on the value of the milk produced by each cow and compare that with the current feed cost.

Records kept will include crops and cropping history including such things as planting and harvesting dates; chemicals and varieties used; yields; and forage test results. Feed information for individual animals (or groups of animals) should include:

- amount and feed value of feedstuffs used
- ration and resulting production (pounds gained or milk produced)
- feed cost
- storage cost and losses in storage
- pasture condition and usage

3. Health

Health records are very important to business success on the farm. They are important both to the management of the animal as well as responsible use of drugs and vaccines. They are needed for a reference in order to do the required vaccinations at the right time. Accurate records can track treatments on an animal by animal basis. This information is valuable to you and your veterinarian in determining and adjusting treatment regimes as animals and environmental conditions change. Effective documentation that shows appropriate compliance, withdrawal and disposal will help avoid possible liability from a residue contamination.

Health records should include:

- Shots, vaccines, treatments given - date, product, dosage, cost, effectiveness of treatment. This part of the record may be divided into routine or preventative treatment, or treatment in response to a problem.
- Illnesses - type of problem, treatment used, number of times treated, withdrawal time, number of animals affected, long lasting effect of illness. This could include a management report listing all animals which have a particular disease to help determine if a particular disease or condition exists in the herd.
- Lifetime health information on each animal in the herd in order to have immediate access to health history.
- Reasons for culling animals.

Health records should be designed by the producer and the farm's veterinarian. Records can be handwritten, part of the DHI report, or on a dairy computer program developed to keep complete and accurate health records.

4. Reproduction

Information on each individual lactating dairy animal that should be kept include:

- Heat dates
- Calving date
- Bred date(s)
- Dry date
- Bull used
- Semen inventory
- Due date
- Service success rate
- Results of veterinary checks (including pregnancy checks).

Information for each individual animal can be recorded using paper records/calendar, 21 day barn wall charts, breeding wheels, Palm pilots and/or on computer.

Whole herd reproduction information is needed to achieve maximum production and reproductive performance. Records need to be kept in order to analyze measures of reproductive efficiency for the whole herd. These include:

- Days to first service
- Days open
- Calving interval
- Services per conception
- Conception rate
- Heat detection rate
- Pregnancy rate

Individual data should be summarized by groups and analyzed to see if reproduction parameters are being met. See the breeding/reproduction section in this manual to learn about reproduction parameters.

5. Production

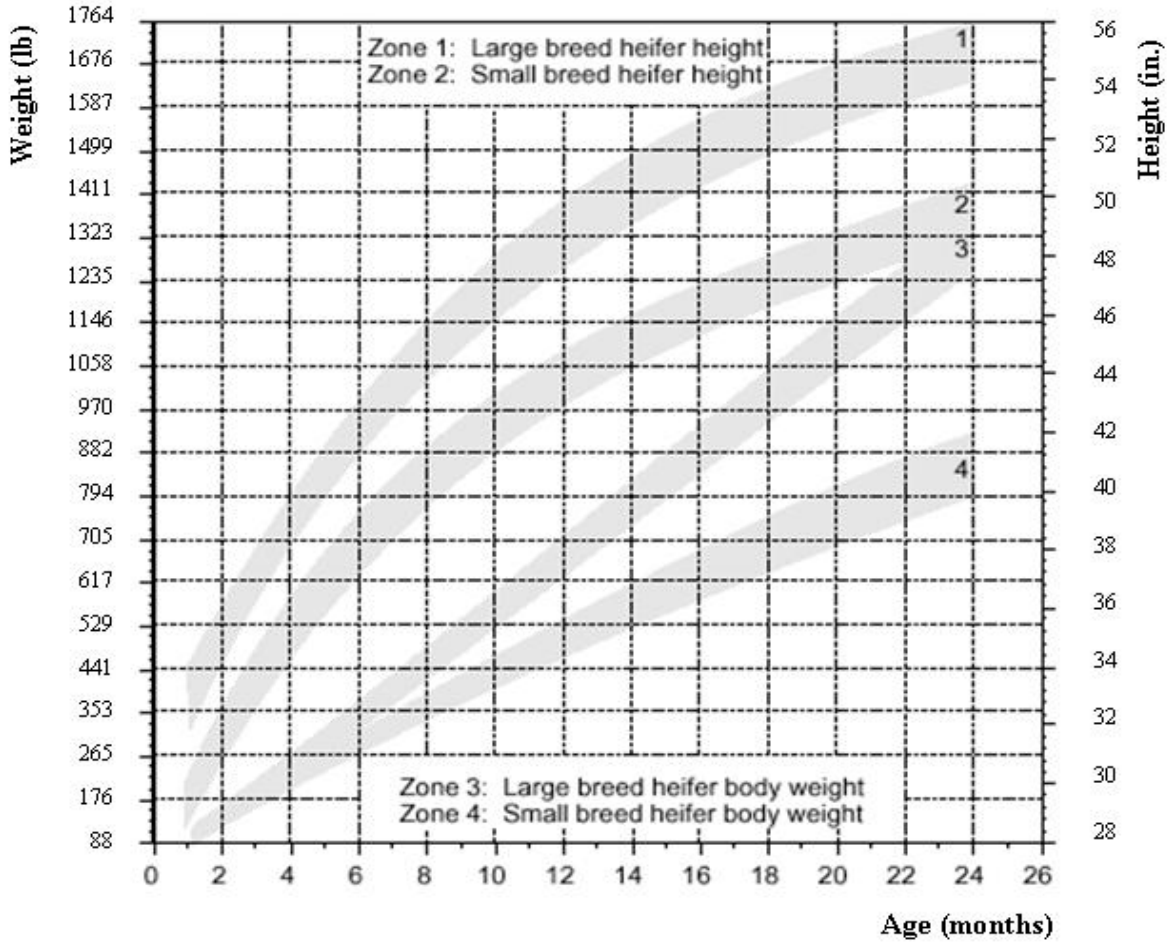
The milk produced and marketed from a dairy farm is key to the ability to pay the bills incurred in operating the business and having a reasonable profit. Milk production is highly variable from cow to cow. It is important to know each cow's production, have it recorded and then used for analysis on a daily, lactation, and lifetime basis. Milk production records, including pounds of milk, fat percentage, protein percentage and somatic cell count, are integral parts of any dairy management record system on the dairy farm

Many farms enroll their herds in the Dairy Herd Improvement Association (DHIA) to obtain production and other management information. DHIA is the most common type of production record system used in Minnesota and the U.S. A number of larger dairy herds have milking systems with weigh jars in the parlor that are incorporated into a computerized system to measure and record production data each milking and then provides immediate information to read and/or print out for analysis if desired.

If your home herd is not on DHIA, you can keep production records by weighing and recording milk weights one day (both milkings) each month. The 4-H Dairy Project in Minnesota recognizes top production records of animals owned by 4-H members. A completed lactation record on the animal from DHIA is required in order to enter this award category.

As a 4-H Dairy Project member, perhaps your project includes a calf or a heifer that has yet not freshened. Raising dairy heifers to an adequate size and with an age at first calving between 22 and 24 months can optimize profitable milk production. To achieve this goal, proper nutrition and feeding management is required so heifers are large enough to breed at 13 to 15 months old. Growth charts that show the preferred growth pattern of an animal from birth to 24 months of age by breed can be found on the internet (see chart for all breeds). Weigh or measure animals on a regular basis and compare the results with the standard growth curve charts.

Calf and Heifer Growth Chart – All Breeds



Source: The Babcock Institute (http://www.babcock.wisc.edu/?q=node/262). Weights and heights converted from metric values.

6. Economic or Financial

Dairy farms must be operated as a business. The continuous, rapid adoption of new dairy technology has increased the need for producers to keep and use complete records to manage their operations.

Financial records should include the price of the milk per hundredweight and to be able to use the data to calculate costs per hundredweight of milk as well as various other financial analyses. Financial records are being used now in production testing programs as well as in programs for consultants and veterinarians.

Although a few producers use financial records primarily for income tax purposes, most producers use this information to make decisions to improve dairy farm profitability. Producers - and 4-H members - must understand and use known financial principles in making decisions that will affect their financial decisions. A decision might be how much to pay for a project heifer, how much to invest in semen, or if and when to expand the current dairy unit.

Some economic tools widely used are an annual income and expense statement, a net worth statement, farm financial ratios, cash flow projections, and short- and long-range budgets. The 4-H member that is serious about dairy business management can obtain a wealth of additional information by contacting the extension service. An excellent resource of financial information can also be obtained at the University of Minnesota Center for Financial Management at www.cffm.umn.edu/.

A. DHI Production and Management Records

The Dairy Herd Improvement (DHI) Records Program was developed to provide management information useful in improving the production efficiency and profitability of dairy herds. Dairy producers often share this information with various consultants who can also help make recommendations for improvement.

DHI records provide information to:

- Track the level of milk production and components (amounts of butterfat, protein, and somatic cells)
- Track health and reproductive information
- Identify bottlenecks
- Troubleshoot problems
- Help make sound culling decisions
- Assist with day-to-day management of the dairy herd

DHI records will help increase profitability in several ways:

- Knowing the amount of milk and milk components given by each cow
- Measuring milk quality and milk urea nitrogen
- Feeding a cow (or group) a ration balanced to her (their) needs
- Increasing production level through judicious culling
- Providing a sound genetic basis for selecting superior sires and foundation females.
- Keeping reproductive performances at an optimum level
- Providing a day-to-day management guide

There are a number of DHI programs from which to choose. A producer needs to identify the needs they have in managing their herd, and then select the program that best fits their individual needs. The Minnesota DHIA web site, http://www.mndhia.org/, explains the type of services and reports offered.

In most programs, the records are computed at a regional processing center. This information provides production, income, reproduction, herd mate comparisons, and component tests on individual animals as well as groups of cows. Most centers provide comparative information between herds.

DHI technicians and field staff, as well as university extension educators and dairy specialists, can help interpret and explain the records. The Minnesota DHIA web site also provides information to help you interpret your herd and individual cow records.

If your home herd is already on DHI, your cow will automatically be enrolled when she freshens with her first calf. If your herd is not enrolled, contact your local association or DHI technician to enroll your cow (and home herd, too) in a records program. If there is not a local association in your area, the state organization can provide service. Local associations are part of the state DHIA association. National DHIA is made up of state or multi-state affiliates. By

having all the affiliates as part of the national association, it allows for uniform program development and implementation and assures that all information and records are accurate, credible and uniform throughout the nation.

B. Economic Considerations and Financial Management

Cost Breakdown of Raising Heifers

A 4-H member should have a good estimate of what the costs will be to purchase and raise a calf until she is ready to freshen. The costs of raising dairy heifer replacements represent 20 to 25% of the total costs of milk production on a dairy farm. Knowing this, it is an incentive to raise high quality productive heifers as economically as possible. The number of replacements required to maintain herd size impacts overall heifer raising costs. Age at first calving is another factor that can affect raising costs. Feed and labor are key control factors that will impact profitability. Keeping good records and recording the information regularly are important to keeping track of these items so they can be evaluated and analyzed to help make management decisions.

The periods from birth to weaning, weaning to puberty, puberty to breeding and breeding to calving are used to further analyze dairy replacement programs.

Keeping heifers healthy, meeting growth goals without over-conditioning, lowering calving age, lowering cull rates, reducing feed costs and improving labor management are key factors for heifer enterprise management. First and foremost, however, is being able to separate costs in order to provide a better picture of the heifer enterprise to help make good management decisions (Hugh Chester-Jones, U of MN Animal Scientist, Sept. 2005). The budget in Table 2 is an example of all the costs involved in raising a calf to 24 months of age at which time she freshens and enters the milking string. Often a 4-H member doesn't think about all the costs involved such as power, supplies, interest, buildings and equipment. However, these costs need to be considered when putting together a budget for the dairy operation to help analyze the business. Your cost items and prices will vary. A space is provided for you to calculate your cost to raise your own dairy heifer project.

Measuring and weighing calves assures proper growth rates

Table 2. Example Dairy Heifer Raising Expenses (0 thru 24 months) by Neil Broadwater, U of MN Extension Educator

				Your Costs
Purchase Animal (a few days old)		**$150.00**		_____
Feed Costs				
Hay @$100/ton (2,130 lb) & C.S. @$30 (1,000 lb)		= 71.50		_____
Forage @$55/ton (Hay & C.S.) — 10,092 lb		= 277.53		_____
Corn (no. 2 shelled) @ 3.00/bu. — 18 bu.		= 54.00		_____
Soybean meal (44% C.P.) @$230/ton — 120 lb		= 13.80		_____
DiCal (24% Ca:18% P) @$18/cwt — 60 lb		= 10.80		_____
TM Salt @$8/cwt — 49 lb		= 3.92		_____
Milk Replacer @$100/cwt — 40 lb		= 40.00		_____
Calf Starter @$18/cwt — 150 lb		= 27.00		_____
_____		= _____		_____
	Total Feed Costs		**$ 498.55**	
Heifer Costs				
Bedding (Straw) @$75/ton — 2,200 lb		= 82.50		_____
Veterinary & Medicine		= 28.00		_____
Breeding @$20/unit — 2 units		= 40.00		_____
Power & Fuel		= 22.00		_____
Supplies, etc.		= 20.25		_____
_____		= _____		_____
	Total Heifer Costs		**$ 192.75**	
Interest @ 7 %			$ **39.16**	
Fixed Costs (int, deprec, taxes, insur, repairs/yr)				
Buildings		= 150.00		_____
Equipment		= 108.00		_____
Livestock		= 152.75		_____
_____		= _____		_____
	Total Fixed Costs		**$ 410.75**	
Labor and Management 24 hrs @$8/hr.			**$ 192.00**	
	Total Cost per head		**$1,483.21**	

Income and Expense Statement - Per Cow Basis

A 4-H dairy project member that starts out at a young age with a calf will generally continue in the program in the years ahead with that same animal as a yearling, when she freshens at around two years of age and throughout one or several lactation periods. A 4-H'er or dairy producer should know - and the agricultural lender will require - the probable income and expenses for a cow or for the whole dairy herd (see Table 3 for an example annual budget for one cow).

Estimating Capital Needs

The capital required to remain in the business of producing milk has increased dramatically in recent years. No doubt, future capital requirements will continue to rise due largely to the continuing adoption of more capital intensive milking, feeding, labor saving technology and waste handling systems. As a result, these increasing capital needs force many dairy farmers to rely heavily on debt. The appropriate debt level depends on many factors, including cow productivity and profitability, interest rate on the debt, debt repayment terms, and the producer's feelings about financial risk. These factors often differ widely between producers. Consequently a sound estimate of debt carrying capacity for an individual producer should rely on a financial analysis of the producer's business (Willett, Washington State).

Developing and maintaining a dairy operation large enough to provide a fair

return to the operator costs a lot of money. It is important to calculate the total investment per cow. The formula is: *Total Investment per cow = Total Assets divided by Number of Cows.* Assets include the value of the cows, land, buildings, equipment and machinery. Too high of investment per cow may stem from a number of causes including: high-priced land; overbuilt facilities; large number of owned acres per cow; new or overpriced machinery; new or overpriced facilities; some combination of these. Each investment should be analyzed to determine if it generates a good return to the dairy business, such as investing in cows and cow comfort. For some dairy operations it may be beneficial to consider alternatives such as custom hiring fieldwork or purchasing all feed rather than over investing in land and machinery for what the business can handle financially.

Generally, dairies in the Midwest have a goal of $4,500-$5,000 investment per cow or less, depending on what milk price is used for calculating income. However, the range varies widely from farm to farm, from around $2,000 to $8,000/cow or more.

Farm Financial Standards

It is important for the dairy producer to monitor the farm's business performance and make the necessary adjustments to correct any bottlenecks that may adversely affect profitability. Producers should always have an overall view of how their business is performing and at least conduct an annual business performance analysis. More than likely a farm may be performing well in some areas but have serious weaknesses in others. An annual business analysis provides the owner with a comprehensive view of how the business has performed in a number of key areas over the past year. To do this, keeping good records is essential.

A "Farm Financial Scorecard" is available at the University of Minnesota Center for Farm Financial Management website, http://www.cffm.umn.edu/Publications/pubs/FarmMgtTopics/FarmFinanceScorecard.pdf which can help evaluate where the business is at financially. Or, contact your local or regional extension office for a copy. The scorecard includes Liquidity, Solvency, Profitability, Repayment Capacity, Financial Efficiency measures to determine if the business is in a strong financial position, is vulnerable, or somewhere in between.

Another source of information that can be used is from a national banking committee that established farm financial ratios which have been used throughout the nation to evaluate an agriculture unit's financial well-being. They are called *The "Sweet 16" Farm Financial Measures* and can be found at the web site, http://agmarketing.extension.psu.edu/Business/Sweet16.html.

Desirable ranges and guidelines vary significantly by type of farm, ownership pattern, time of year and technology. Every serious dairy business person (or future producer) needs to learn as much as possible about how to evaluate the farm's business financial well-being. Evaluating the profitability and sustainability of the dairy farm business based on all these measures gives a more accurate assessment than just using a few. All of the areas represented by the measures are important to the long-term viability of a business — and are related to and influenced by each other.

Table 3. Budget of income and expenses for one milking cow giving 20,000 or 24,000 pounds of milk
(Source: Iowa St. University 2006 Dairy Cow Annual Budget for Northeast Iowa)

Northeast Iowa Dairy Cow Annual Budget- Freestall - April 2006 Large Breed Dairy Cow Including Replacements Producing 20,000 lbs. & 24,000 lbs. of Grade A Milk								
I. RECEIPTS				$$ Value				$$ Value
1. Components:	200	cwts.			240	cwts.		
a. Butterfat	730	lbs.	1.2343	$/lb.	$901.04	876 lbs.	1.2343	$/lb.	$1,081.25
b. Protein	608	lbs.	1.9238	$/lb.	$1,169.67	729.6 lbs.	1.9238	$/lb.	$1,403.60
c. Other Solids	1144	lbs.	0.1508	$/lb.	$172.52	1372.8 lbs.	0.1508	$/lb.	$207.02
d. Producer Price Differential			0.56	$/cwt.	$112.00		0.56	$/cwt.	$134.40
e. Quality	267,000	SCC	0.00058	$/thousand	$0.154860	267,000 SCC	0.00058	$/thousand	$0.154860
f. Protein Premium			0	$/lb.	$0.00		0	$/lb.	$0.00
g. Volume			0.185	$/cwt.	$37.00		0.185	$/cwt.	$44.40
2. Capital Payout			0	$/cwt.	$0.00		0	$/cwt.	$0.00
3. Cull/cow (a)	0.36	head	$450.00	per hd.	$162.00	0.39 head	$450.00	per hd.	$175.50
4. Dairy calf	0.51	head	$200.00	per hd.	$102.00	0.52 head	$200.00	per hd.	$104.00
5. Replacement heifer calf	0.18	head	$450.00	per hd.	$81.00	0.21 head	$450.00	per hd.	$94.50
6. MILC payment			$0.8398	$/cwt.	$167.96		$0.8398		$201.55
GROSS RECEIPTS					**$2,905.34**				**$3,446.38**
II. VARIABLE COSTS									
A. FEED COSTS (b)	Price/Unit		Amount		$$ Value		Amount		$$ Value
1. Corn equivalents	$2.00	per bu.	104.38	bu.	$208.76		112.91	bu.	$225.82
2. Corn Silage	$20.00	per ton	8.04	tons	$160.80		7.99	tons	$159.80
3. Hay equivalents	$125.00	per ton	6.09	tons	$761.25		6.03	tons	$753.75
4. Salts and minerals	$0.14	per lb.	241.97	lbs.	$33.88		323.23	lbs.	$45.25
5. Protein supplement	$0.11	per lb.	1284.83	lbs.	$138.12		1855.08	lbs.	$199.42
6. Whole (linted) cottonseed	$0.09	per lb.	724.5	lbs.	$65.21		1361.25	lbs.	$122.51
7. Fat	$0.35	per lb.	26	lbs.	$9.10		111	lbs.	$38.85
8. Milk replacer, calf starter					$44.00				$44.00
9. Total Feed Costs					**$1,421.11**				**$1,589.41**
B. LIVESTOCK COSTS					$$Value				$$Value
1. Milk marketing per cwt.	$0.30		200	cwts.	$60.00	$0.28	240	cwts.	$66.00
2. Veterinary and Health					$98.00				$118.00
3. Fuel, utilities and repairs					$100.00				$110.00
4. DHIA & accounting					$28.00				$30.00
5. Breeding fees					$35.00				$43.00
6. Bedding, supplies and misc.					$160.00				$170.00
7. Total Livestock Cost					$481.00				$537.00
8. Operating Capital Interest	8%		3	months	$38.04		3	months	$42.53
9. Total Variable Costs					**$1,940.15**				**$2,168.93**
III. FIXED COSTS (c)									
1. Machinery, equipment, facilities					$310.00				$340.00
2. Interest & Ins. on Herd	7.50%	annually			$126.82				$152.25
3. Death Loss	3.52%	x $1400.00			$42.24	3.47%	x $1540.00		$46.50
4. Total Fixed Cost					**$479.06**				**$538.75**
IV. TOTAL COST		per cwt. (d)			per cow		per cwt. (d)		per cow
(except for labor and management)		**$10.11**			**$2,419.21**		**$9.53**		**$2,707.68**
V. RETURNS		per cwt. (d)			per cow		per cwt. (d)		per cow
1. Gross receipts		$12.99			$2,905.34		$12.98		$3,446.38
2. Less variable costs		$8.11			$1,940.15		$7.63		$2,168.93
3. Returns above variable costs		$4.03			$965.19		$4.49		$1,277.44
4. Less fixed costs		$2.00			$479.06		$1.90		$538.75
5. Returns to labor & management		$2.03			$486.13		$2.60		$738.69
6. Less labor cost 45 hrs. @ $10/hr.		$1.50			$360.00		$1.27		$360.00
7. Returns to management		**$0.53**			**$126.13**		**$1.33**		**$378.69**
VI. BREAK EVEN MILK PRICE (e)									
1. Budget break even per cwt.					**$12.1711**				**$11.2237**
2. Actual milk price received this month					$11.9619				$11.9618
3. Actual price received this month+MILC payment					$12.8017				$12.8016

Cattle and Humans

The production of dairy products is important to people around the world. Dairy products such as milk, cheese and butter are an important part of human diets in nearly every country. Most of the milk produced comes from dairy cows, but goats, sheep and water buffalo provide milk to people in some African and Asian countries. The dairy cow is the most efficient among all farm animals in converting feed to both protein and energy for human use.

Through selective breeding and improved management, humans have increased milk production per cow in order to have an ample supply to feed millions of people. In addition, constant improvement through inventions and research has created many new dairy products and a safer food supply, and made dairying easier for the farmer.

History of the Dairy Industry

Dairy cows were brought to Jamestown Colony in 1611 and to Plymouth Colony in 1624. There was minimal work done in selective breeding of dairy cows until the 1860s. The dairy industry prior to the mid-1800s consisted of the family cow. Most families owned one or two cows that were used to supply dairy products for the family. A few farmers sold milk consumers transported by foot or by wagons. The first regular shipment of milk by rail occurred in 1841 from Orange County, New York to New York City. The milk was not refrigerated, so the shelf-life, or time that milk could be kept from spoiling, was very limited.

A major growth and expansion of the U.S. dairy industry took place in the late 1800s and early 1900s with the importing of large numbers of dairy cattle from Europe. By 1925, importations decreased significantly due to the improvement of American dairy cattle through selective breeding and disease concerns with imported cattle.

Production testing and recording were important elements in developing superior cattle in America. The invention of the Babcock test by Steven Babcock in 1890 provided a simple test for measuring butterfat content of milk. This idea along with recording milk yield created the need for forming a testing association. The first testing association was begun in Michigan in 1905. Even today, milk record programs are available to any dairy producer through the Dairy Herd Improvement associations.

Following is a listing of some of the important dates depicting the history of the dairy industry.

1525 – The first cattle brought to the Americas arrive at Vera Cruz, Mexico and soon after, some made their way across the Rio Grande to what is Texas today.

1600s

1611 – First cows arrived at Jamestown Colony

1624 – First cows arrived at Plymouth Colony

1700s

1780 – First reported use of artificial insemination with dogs in Italy

1796 - English physician Edward Jenner developed a vaccine for smallpox using the cowpox virus.

1800s

1810 – First dairy cooperative in the United States organized in Goshen, Connecticut

1841 – First regular shipment of milk by rail (Orange County to New York City)

1851 – First commercial cheese factory established in New York

1856 – Gail Borden received first patent for condensed milk. Condensed milk is cow's milk from which water has been removed (roughly 60% of it). It is most often found with sugar added, in the form of sweetened condensed milk (SCM), to the extent that the terms "condensed milk" and "sweetened condensed milk" are often used interchangeably today. SCM is a very thick, sweet product, which when canned can last for years without refrigeration if not opened.

1857 – First commercial butter factory established in New York

1862 – The Morrill Act was enacted creating the land grant college system

1864 – First recognized exhibition of dairy cattle in the U.S. (New England)

1864 – French chemist and biologist Louis Pasteur, considered one of the fathers of microbiology, helped prove that infectious diseases and food-borne illnesses were caused by germs, known as the "germ theory." Pasteur's research demonstrated that harmful microbes in milk and wine caused sickness, and he invented a process - now called "pasteurization" - whereby the liquids were rapidly heated and cooled to kill most of the organisms.

1868 – American Jersey Cattle Club formed

1868 - The first cheese factories in Minnesota were established. A cooperative cheese plant in Owatonna, Minnesota procured milk from 600 cows within a four mile radius each day. The managers received two cents a pound for making the cheese and each farmer received dividends according to the amount of milk he furnished.

1869 – Oleomargarine was patented by a French chemist. The name was shortened to margarine. Unfortunately for the dairy industry margarine replaced some of the demand for butter. By the end of the 20th century, an average American ate around 5 lb of butter and nearly 8 lb of margarine.

1873 – First silo in the U.S. built in Illinois. Corn silage provided a much higher energy and more palatable feed than the lower quality hay common at the time for winter feeding. This ensured a more consistent quantity of milk produced throughout the year.

1877 – American Guernsey Cattle Club founded

1878 – Dr. Gustav Delavel, a Swedish engineer, invented the centrifugal cream separator. Most dairy farms in Minnesota soon had a cream separator in the milk house. The milk was separated into cream and skim milk. The "cream can" was delivered to the local creamery. The skim milk was used by the family, fed to calves, and made an excellent supplement to the grain based diet fed to the pigs. By 1898, more than 550 cooperative creameries existed in Minnesota. The state became known for its butter. In 1928, nearly half of the cooperative creameries in the United States were in Minnesota.

1880 – Brown Swiss Breeders Association founded

1883 – New York Milk War – New York Dairy Farmers blocked roads and dumped milk until milk retailers agreed to pay a higher price.

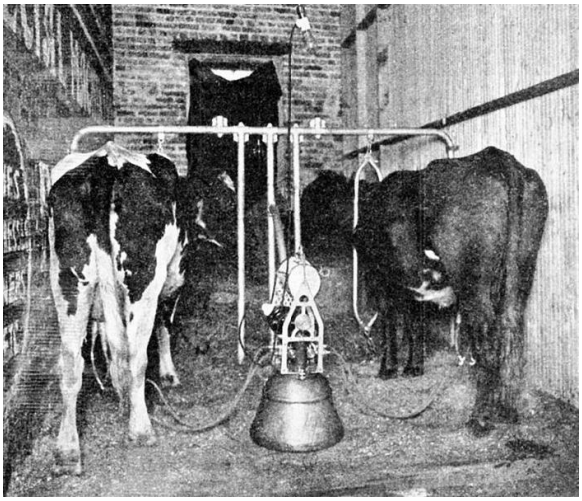
1884 – Milk bottle invented by Dr. Harvey D. Patch of Potsdam, New York after seeing a milkman making deliveries from an open bucket into which a child's filthy rag doll had accidentally fallen.

1885 – Hoard's Dairyman magazine first published

1885 – Holstein-Friesian Association of America chartered

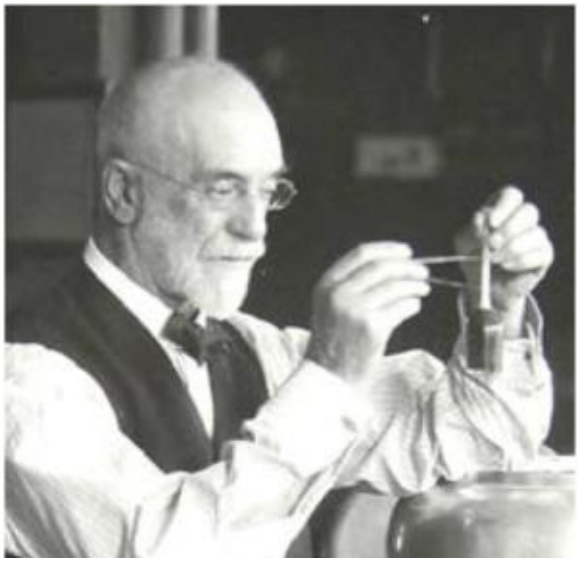
1887 – The Hatch Act was enacted creating state agricultural experiment stations.

1889 – The Murchland machine was the first commercially successful milking machine. While good at extracting milk, the continuous vaccum to the teat cause discomfort to the cow and kicking was common.



1890 – Tuberculin testing of dairy herds initiated. This tested cows for Tuberculosis.

1890 – Babcock Test for fat content in milk and cream developed by Dr. S.M. Babcock at the University of Wisconsin. Butter fat was the most valuable component of milk. This test allowed farmers to select cows with a higher fat content. It allowed processors to pay for fat content and discouraged the watering down of milk. The Babcock test was utilized all over the world and served as the standard for over 80 years.



1893 - Milk produced under unhygienic production practices served as a medium to spread diseases like typhoid and tuberculosis, which led to skyrocketing infant mortality in the cities. The Medical Milk Commission was established to certify production of milk for cleanliness.

1894 – Dr. Gustav Delavel patented his first milking machine. It was not until 1918 that the first commercially practical Delavel milking machine was marketed.

1895 – Dairy Division established in U.S.D.A.

1895 – Pulsator invented – The intermittent vacuum created by the pulsator allows free blood flow through the teat preventing edema the injury to the teat during the milking process.

1895 – Commercial pasteurizers introduced. Pasteurization ensured a much safer dairy product for consumer. Unfortunately, pasteurization was not made mandatory until 1917.

1899 – Milk Homogenizer was invented that prevents the cream from separating and rising to the top as it does in un-homogenized milk.

Early 1900s

1900 – AI was successful with cattle in Russia

1905 - First cooperative cow testing association organized in Michigan. Milk lb and % fat were the only traits tested.

1906 - First National Dairy Show in Chicago, Illinois

1906 - First National Collegiate Dairy Cattle Judging contest

1906 – National dairy council is organized

1906 – Brown Swiss recognized as a dairy breed in the US.

1908 - First compulsory pasteurization law (Chicago)

1913 - A large typhoid epidemic in New York City was attributed to contaminated milk from a single milk company.

1914 - Tank trucks first used for transporting milk

1914 - Smith-Lever Act signed establishing the cooperative extension service

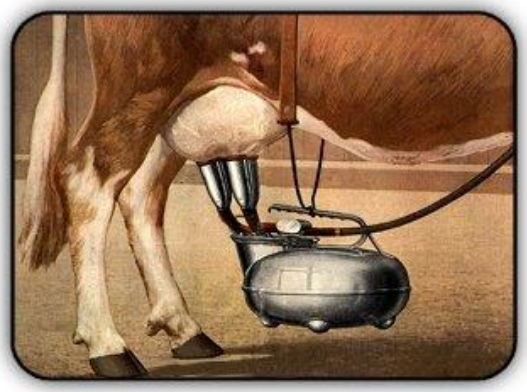
1915 - The National Dairy Council was first formed by dairy farmers and processors to protect the public's good image of dairy in light of a foot-and-mouth disease outbreak. Today, the dairy producer-funded NDC is a highly-credible science-based nutrition information resource to schools, and health professionals.

1917 – Mandatory milk pasteurization begins except for cows proven free of tuberculosis.

1922 - Capper-Volstead Act passed by U.S. Congress – The act was of historic significance because it exempted ag cooperatives from anti-trust laws; allowing producers of agricultural products, such as milk, to "act together in associations" to organize collective processing, preparation for market, handling, and marketing of milk and other agricultural goods.

1922 - Herbert McCornack invented the Surge Bucket Milker. He used a large roasting pan from his family kitchen as the base to design his new milking machine. This revolutionary milker would hang under the cow suspended on a steel spring rod that was attached to a leather surcingle strap over the cows back. The Surge bucket offered several advantages over other machines:

much easier to sanitize, vacuum to the teat cup automatically shut off if it fell off the teat, and the pulsator was more easily serviced. By 1955, 76% of dairy cows in the U.S. were milked with Surge buckets.



1930s

1932 - First plastic-coated paper milk cartons introduced commercially

1933 - Sioux City Milk War - In 1933 milk producers in Iowa organize a strike for higher milk prices. One of the main tactics farmers used during the strike was to block roads and prevent milk from being shipped to Sioux City. In one instance, strikers opened fire on a truck driver who was trying to get past a road blockade they had set up, seriously injuring four of the passengers.

1935 - National Cooperative Sire-Proving initiated by U.S.D.A.

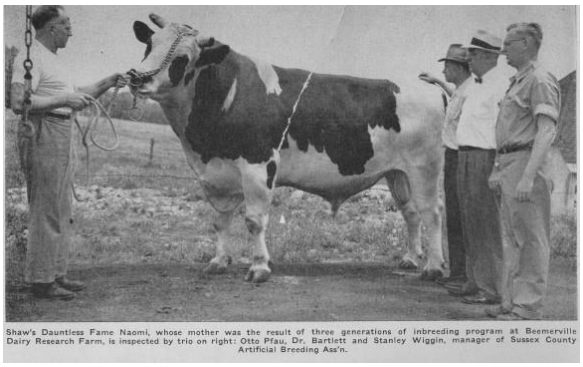
1937 - First list of sires proved in DHIA testing published by U.S.D.A.

1937 - First Milk Marketing Orders Initiated - "Milk marketing orders came into existence as a result of the Agricultural Marketing Agreement Act of 1937... The rationale for the legislation was to reduce disorderly marketing conditions, improve price stability in fluid milk markets, and ensure a sufficient quantity of pure and wholesome milk.

1938 – 1st cow bred artificially in Minnesota at the University of Minnesota – St. Paul Campus

1938 - First AI cooperative in U.S. formed in New Jersey

1939 – First AI cooperatives formed in Minnesota



Shaw's Dauntless Fame Naomi, whose mother was the result of three generations of inbreeding program at Beemerville Dairy Research Farm, is inspected by trio on right: Otto Pfau, Dr. Bartlett and Stanley Wiggin, manager of Sussex County Artificial Breeding Ass'n.

1940s

1940 - American Dairy Association formed to promote U.S. milk products to consumers through advertising and retail promotions. ADA is best known for its use of the "REAL Seal" on U.S.-made dairy products and on other products containing U.S. dairy.

1940 - Purebred Dairy Cattle Association (PDCA) formed

1940 – First Federal Milk Program for Schools – Elementary school children in low-income areas of Chicago were proved free milk.

1942 - National Association of Animal Breeders (NAAB) organized. The NAAB is the trade organization of A.I. studs. The purpose of the NAAB as defined by its By-Laws is "...to unite those individuals and organizations engaged in the artificial insemination of cattle and other livestock into an affiliated federation operating under self-imposed standards of performance and to conduct and promote the mutual interest and ideals of its members." The NAAB provides industry self-regulation in the areas of semen and sire health and identification. The NAAB conducts various marketing and promotion programs and provides educational materials to expand the use of AI in dairy and beef herds

1943 - The "Dairy Cow Unified Score Card for Judging Cattle" develop by PDCA

1946 – National School Lunch Act signed into law by president Harry Truman - It was mandated that each lunch include between 1/2 to 2 pints of whole milk.

1948 - Ultra-high pasteurization introduced. UHT milk was first developed in the 1960s and but UHT milk was not available to the public until 1982. UHT milk packaged in a sterile container, if not opened, has a typical unrefrigerated shelf life of six to nine months.

1950s

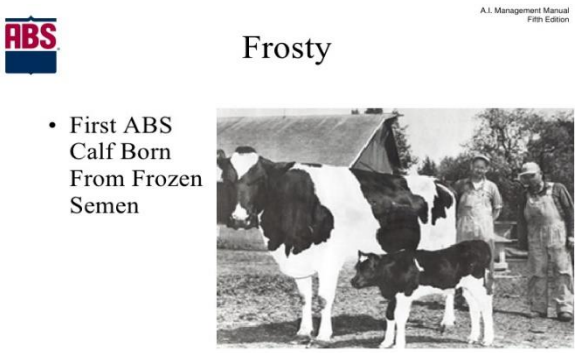
In the 1950s and 1960s many dairies began to introduce the square paper carton to replace bottles. The square shape allowed more milk to be carried and displayed in a given space than did the old glass bottles and reduced the cost of milk to consumers.

1951 - Computer first used to calculate DHIA records in Utah

1951 -First young sire sampling program established in U.S.

1952 - First reported successful embryo transfer in dairy cattle

1953 – 1st calf born from frozen semen in the U.S. The calf was named Frosty.



1954 - State-Federal cooperative brucellosis eradication program began. Brucellosis was the most significant livestock disease in the U.S. with an estimated over 10% of adult cattle infected. Brucellosis could be transmitted to humans through unpasteurized dairy products, aborted fetuses, placental membranes and fluids, and other reproductive tract discharges of an infected animal. National eradication in cattle was mostly achieved by the early 2000s. Minnesota was given a Brucellosis Class Free status in 1985 and has maintained it through present day.

1955 - Flavor control equipment introduced commercially

1960s

1960 - National Mastitis Council founded

1961 - United States Department of Agriculture (USDA) began using the herdmate method of comparison for sire summaries

1964 - Commercial introduction of plastic milk jug

1965 - National Dairy Herd Improvement Association organized

1967 - Non-dairy milk substitutes introduced

1967 – World Dairy Expo was founded

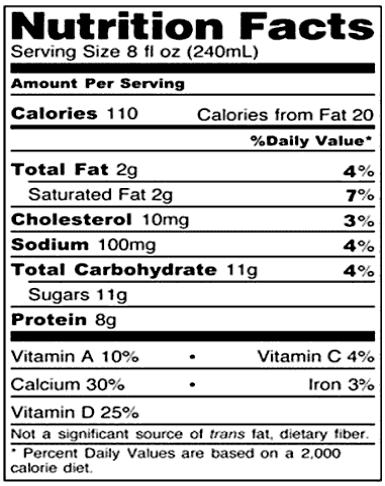
1968 - Official acceptance of electronic testing for milk fat content. This replaced the use of the Babcock test at milk plants and for DHIA testing.

1970s

1970 - United Dairy Industry Association (UDIA) is formed by the merger of National Dairy Council® (NDC) and American Dairy Association® (ADA).

1974 - First registered embryo transfer (ET) Holstein bull born.

1974 - Nutrition labeling of fluid milk products begun after the FDA advised that all foods should have nutrition labels.



Nutrition Facts
Serving Size 8 fl oz (240mL)

Amount Per Serving	
Calories 110	Calories from Fat 20
	%Daily Value*
Total Fat 2g	**4%**
Saturated Fat 2g	**7%**
Cholesterol 10mg	**3%**
Sodium 100mg	**4%**
Total Carbohydrate 11g	**4%**
Sugars 11g	
Protein 8g	

Vitamin A 10%	•	Vitamin C 4%
Calcium 30%	•	Iron 3%
Vitamin D 25%		

Not a significant source of *trans* fat, dietary fiber.
* Percent Daily Values are based on a 2,000 calorie diet.

1974 - The USDA modified contemporary comparison (MCC) replaced the herdmate method of comparison resulting in increased accuracy of sire summaries

1975 – A patent was granted for automatic take-offs for milking machines. This allowed for more consistent milking and reduced labor requirements.

1980s

1980 - Bacillus stearothermophilus disc assay approved as official test for antibiotic residues

1980 - First estrus synchronization drug given approval by the FDA

1981 - The Dairy Shrine Museum in Fort Atkinson, WI was dedicated

1982 - Ultrahigh temperature (UHT) milk first introduced to U.S. public at Worlds' Fair in Knoxville, Tennessee

1983 - Dairy Act of 1983 and the Creation of the National Dairy Board - This self-help program is funded by a mandatory 15-cent-per-hundredweight assessment on all milk produced in the contiguous 48 States and marketed commercially by dairy farmers. The purpose is dairy product promotion, research, and nutrition education to increase human consumption of milk and dairy products and reduce milk surpluses. It is administered by the National Dairy Promotion and Research Board (Dairy Board).

1989 - Animal Model first used for USDA genetic evaluations

1990s

1992 – The automatic milking systems (AMS) or robotic milking was introduced to the European market.

1993 – Recombinant Bovine Somatotropin (rbST) approved by United States FDA for commercial use in the U.S. bST is another name for bovine growth hormone (BGH).

1993 - First grade Holsteins recorded in the Qualified Holstein herdbook

1994 - First commercial sale of rbST to U.S. dairy producers. In a short time BST was routinely administer to 30% of U.S. dairy cows to increase milk production by about 10%. Due to consumer resistance to the use of hormones to enhance milk production, rbST use was phased out in the U.S. in the 2010s.

1994 - First USDA genetic evaluations for somatic cell score (SCS) and productive life (PL). The Net Merit Dollar Index (NM$) was first publish and contained PTAs for Milk, Fat, Protein, PL and SCS.

1995 - Dairy Management, Inc. (DMI) formed as the organization responsible for increasing demand for U.S.-produced dairy products on behalf of America's dairy producers; direct coordination between national and local dairy promotion programs begins.

1995 Multi-trait across country evaluation (MACE) for sire evaluations was implemented. This allowed the comparison of sire evaluations across different countries so the bulls across the world could be directly compared to each other. [JAS1]

2000s

2000 – Body size composite, udder composite, and feet/legs composite were added to the NMS joining Milk, Fat, Protein, PL and SCS.

2000 – First commercial robotic milker installed on a farm in Wisconsin.

2002 - People for the Ethical Treatment of Animals (PETA) filed a lawsuit against the California Milk Advisory Board claiming that the CMAB's "Happy Cows" advertising campaign constituted false advertising. They charged that the idyllic living conditions of the "Happy Cows" were in stark contrast to the large factory farm reality of most dairy cows in California. The suit was thrown out of court.

2003 – Daughter pregnancy rate (DPR) was added to NM$ and calving ability (CA$) was added in 2006. The four components that go into CA$ are sire calving ease (SCE), daughter calving ease (DCE), sire stillbirth rate (SSB) and daughter stillbirth rate (DSB).

2004 – Sexed semen became commercially available in the U.S. This increased genetic progress as farmers could breed their best genetic animals to sexed semen for heifer calves. It also let to a surplus of heifer calves and springing heifers sold for less than the cost of raising them.

2005 – First robotic milker (AMS) was installed on a dairy in Minnesota.

2006 – Dairy Cattle Reproductive Council is formed.

2008 - FDA Approves Cloned Milk for Human Consumption - the FDA wrote that "meat and milk from clones of cattle, swine, and goats, and the offspring of clones from any species traditionally consumed as food, are as safe to eat as food from conventionally bred animals."

2009 – L1 Dominette 01449, a Hereford, was the first bovine to have its complete genome sequenced. This led to the enhanced genomic evaluations and the possibility of gene edited in cattle.

2009 – First genomically enhanced PTAs were published

2010s

2013 Council for Dairy Cattle breeding takes over sire evaluations from USDA.

2015 – First gene-edited hornless calves born. The company called Recombinetics took tissue from a crossbred diary bull calf born at the U of MN St Paul dairy, edited the gene to produce polled cattle, and two resulting hornless clones resulted.

2017 – Live ability (LIV) was added to NM$. LIV is the probability of a cow not dying from one year to the next.

2018 – Heath traits (HTH$) were added to NM$. HTH$ selects for resistance to the following diseases: milk fever, displaced abomasum, ketosis, mastitis, metritis, and retained placenta.

2020 - Dairy farmers dump up to 3.7 Million Gallons of Milk per Day Due to COVID-19 Pandemic. Due to school and restaurant closures during the COVID-19 (coronavirus) pandemic, demand for milk dropped sharply. Low demand, combined with processing bottlenecks and grocery store ordering caps, forced milk farmers to dump milk before it is delivered to processors. The World Dairy Expo and many other dairy programs were cancelled.

Behavior of Dairy Cattle

Dairy cattle are usually easygoing, curious animals with dispositions suited to human contact. This is especially true for milk cows because they are in direct contact with humans on a daily basis. The total performance of a cow (health, production, temperament) depends on the amount and kind of individual attention she gets.

Dairy cattle are creatures of habit that respond favorably to calm and consistent handling practices. Understanding how cattle react to different situations is an important factor in successfully managing a dairy herd. Behavior of dairy cattle can be defined as their reaction to other animals, to stress and to people. Grouped together, these factors are called the environment. Knowing how and why cattle react to their environment will allow the owner/handler to become more efficient in working with dairy cattle.

Cattle have a long memory of their good and bad experiences. Tameness is a learned behavior. Therefore, it is important to treat animals in a kind and gentle manner. Cattle are sensitive to touch. Consistently gentle but firm contact results in tame cattle, while surprising or unpleasant contact can create a response from cattle that can cause injury to themselves or the people working with them.

Cattle can be unpredictable, especially when they are sick, injured, scared or experiencing changes in hormone levels. Dairy cows at calving time tend to be very protective of their newborn calves. Extreme caution is needed when working around the cow and newborn calf. Dairy bulls of any age should not be trusted. When dairy bulls are located on your farm the following precautions should be followed

1) Use a nose ring.
2) Be especially observant when you are in the pen with a bull that is with or near cows and heifers. Know where the bull is at all times.
3) Never turn your back on a bull and always plan an escape route.
4) Never handle older bulls (over 1 year old) alone; make sure another person is with you.

Safety and Dairy Cattle

Working with livestock and the various jobs on a dairy farm can be a very rewarding experience or career. However, both youth and adults must become knowledgeable of the handling techniques required to do the work safely. Certain jobs can require special training and some jobs should not be done by younger children. Safety is the key.

When working with cattle it is important to understand their behavioral patterns. Always work in a calm, sensible manner. Speak to the animal when approaching to alert the cow of your presence and avoid frightening cattle with loud or erratic noises. Milking chores should be done by older youth or adults. Treat milking cows with special care since stress will lower the cows production because nervous cows won't "let down" their milk. Bring heifers through the milking facility several times before calving to accustom them to their new routine.

Halter training dairy cattle is necessary if you plan to exhibit cattle at the fair or breed shows. Some producers break all of their cattle to lead because it allows them to have better handling control when working with individual animals on the farm. Halter training cattle can be dangerous if certain safety tips are not followed. Always remain quiet and calm, but firm.

Start training the calves at three to six months of age, when they are easier to handle. Youth will need adult supervision and help during the first few training lessons. Short, frequent training sessions are better than occasional, long ones. This will help avoid the animal and trainer from getting over tired and perhaps losing patience, which could be a cause for an accident. It is also important to wear protective boots or shoes to avoid serious foot injury in case the animal steps on you.

Accidents can happen anytime. However, the risk of dairy farm accidents can be reduced significantly with proper job training and a good understanding of cattle behavior.

Manure Management, Water Quality and Air Emissions

Manure management is an important part of the overall management and operation of a dairy. Environmental regulations and public concern for water and air quality and sustainability have a direct effect on the dairy industry and highlight the importance of good manure management. Manure and other dairy wastes contain organic matter, plant nutrients, inorganic salts and pathogenic organisms that can contaminate surface and ground water if not handled properly. Dairy barns and stored dairy wastes can be sources of odors and gas emissions. Knowledge and understanding of proper dairy waste management practices provide for a cleaner and safer environment.

Dairy Manure Production

The amount of manure produced by cows depends on body weight and the amount of milk produced. Lactating dairy cows on average produce about 1.7 cubic feet (ft^3) of manure per day per 1000 pounds (lb) of live weight. This equals about 106 lb or 13 gallons of excreted manure per 1000 lb live weight, daily. Table 1 gives approximate manure production for various animal sizes. Manure characteristics can vary by as much as 30% plus or minus.

Table 1. Daily dairy cattle manure production, solids and liquids, not including bedding and assuming 88% water. Manure density is typically 65 lb/ft^3 for young stock and 62 lb/ft^3 for cows.

Animal size (lb)	lb/day	ft^3/day	Gallon/day
150	13	.20	1.5
250	21	.32	2.4
750	65	1.0	7.8
Lactating cows			
1,000	106	1.7	12.7
1,400	148	2.4	17.7
Dry cows			
1,000	82	1.30	9.7
1,400	115	1.82	13.6

Bedding

Various bedding materials are used in dairy systems. The type of bedding used affects the manure handling system and equipment that can be used. The bedding material chosen should provide efficient moisture absorption while minimizing the potential for harmful organisms to grow. Clean and dry bedding is an important tool to manage bacteria growth and reduce lactating cow teat-end exposure to mastitis causing organisms. Bedding availability and cost are important to consider when selecting a bedding material.

Traditional bedding sources include straw, sawdust and shavings. Other organic bedding sources include corn stover, seed hulls, recycled newsprint and recycled manure solids. In addition, inorganic bedding materials such as sand and crushed limestone are common in freestall dairy housing. When managed properly, almost any dry, comfortable and flexible material can be an effective bedding source. However, the use of certain bedding materials can restrict the manure handling equipment and storage system used.

Finely chopped organic bedding including sawdust and shavings can be used on stall mattresses and packed clay bases. Manure with finely chopped bedding can be handled with pumps, gravity flow pipes, flush systems or slotted floor barns. Long straw and other course bedding materials are best handled using scrapers, solid piston pumps and front-end loaders.

Sand can provide a comfortable freestall surface for dairy cows. Sand is flexible and does not absorb moisture. Freestalls with sand need to be kept full of clean dry sand to provide a less friendly environment for mastitis-causing microorganisms. Wet freestalls with manure in them lead to dirtier cows and more microorganism exposure. Sand that is worked out of the freestalls into the alley also helps prevent cows from slipping. Sand laden manure, a mixture of manure and sand, can be handled as a semi-solid but care must be used. Sand settles out of sand laden manure very slowly unless excess water is added, which can cause rapid settling. Sand laden manure is abrasive and causes manure pumping, auguring and scraping equipment to wear out more quickly. Clean out ports need to be provided in transfer pipes. A front-end loader or skid loader with a bucket can be used to remove sand that settles at the bottom of a manure storage unit. Crushed limestone can be used instead of sand and handled in a similar manner.

Sand can be separated from sand laden manure and cleaned for reuse as freestall bedding by either mechanical sand separators or sand lanes. The separated sand from the sand laden manure is reused as bedding in the freestalls while the separated manure solids and liquid are handled as a liquid.

Well-managed mattresses can provide comfortable and clean freestalls without the manure handling complications found with sand. Mattresses covered with dry organic bedding can keep the freestall surface dry and cows clean.

Organic bedding can be used in loose housing and pens to form either a conventional deep bedded manure pack or a composting pack. A conventional pack is where organic bedding is added as needed and allowed to accumulated before being removed and land-applied to cropland. Conventional packs have been associated with high incidence of mastitis. Composting packs in compost dairy barns are packs that use sawdust, wood shavings and similar organic bedding. The compost barn packs are stirred twice a day to encourage aerobic biological activity similar to that in compost. Composting packs need very good management to perform well. Well managed compost barns have been associated with a reduced incidence of mastitis. Sand cannot be used as bedding with manure packs or composting packs.


Well bedded sand freestalls

Collection and Storage

Dairy manure handling systems must collect manure and dirty bedding from pens, manure alleys and holding areas, anywhere cows are housed. Collected manure is typically transported to a treatment facility or a storage unit. Manure can be transported by several methods including scraping, gravity flow, pumping, auguring, flushing or loading into a transport unit. Manure transport methods that can be used depend on the percent solids of the manure.

Bedding increases the solids content and the volume of the manure. When sizing a manure storage for a system using organic bedding, increase the storage volume by one half or more of the total bedding volume. When sizing a manure storage for a system using sand, increase the storage volume by the amount of sand used.

Solid and semi-solid manure has 15 to 30 percent solids and can be collected with scrapers, blades and front-end loaders. Manure and dirty bedding from loose housing with a conventional deep manure pack or bedded pens is handled and stored as a solid. Manure from settling basins is also handled as a solid. Solid manure can be stored as a stack (with or without sidewalls) or in a concrete lined manure pit with a ramp. Most solid manure storage units have drains that allow rainwater and liquids to move away from the stored solid manure. A picket dam structure can be used to drain solid manure. This structure can be built with continuous vertical slots about 3/4 inches wide between standing planks or pickets that hold manure solids back and allows liquid to drain through. The drained liquid is polluted and must not be allowed to enter public waters. The drainage water must be directed to either a holding basin or approved vegetative filter for absorption into the soil.

Slurry manure has up to 15 percent solids. Slurry manure is collected through slotted floors or with scrapers. It can be transported using gravity flow channels or pumps. Slurry manure can be stored in below ground tanks, lined earthen storage basins and above ground tanks. Slurry manure is typically land applied using tanker wagons or tow hose systems.

Liquid manure with less than 5 percent solids can come from flushing systems, liquid-solid separator systems and milk house or milking centers. Liquid manure is collected using pumps or gravity flow and can be stored in below ground tanks, lined earthen storage basins and above ground tanks. It can be spread on cropland using tanker wagons, tow hoses or irrigation equipment.


Concrete lined manure storage.

Milk House / Milking Center Wastewater

The amount of milking center wastewater generated varies greatly depending on the methods used to clean cow udders, floors and the milking system and the number of cows milked. Milking center wastewater is handled as a liquid. It can be added to a liquid manure storage or handled with a separate milk house wastewater treatment system. Human toilet wastes should not be mixed with milk house or milking center wastewater.

Anaerobic Digestion and Solid-Liquid Separation

Dairy manure slurries from barns using organic bedding can be used to feed an anaerobic digester to produce biogas. Microorganisms in anaerobic digesters breakdown the manure to produce methane, carbon dioxide and small amounts of other gases. The biogas can be used to generate electricity or heat. The gases produced can be hazardous and need to be handled properly.

The liquid slurry leaving an anaerobic digester and slurries from barns using organic bedding can be passed through solid-liquid separators to separate the solids from the liquids. The solids can be used as bedding in freestalls or a soil amendment as part of a nutrient management plan. The liquid effluent with valuable nutrients is stored before it is applied on nearby cropland at rates that meet crop needs.

Lot Runoff

Lot runoff is from rain or snow melt that falls on or flows through the cow confinement area and is contaminated with manure, soil and other debris. Lot runoff must be contained and handled as part of the manure management system. Rain water from roofs and areas without livestock is considered non-polluted and does not need to be handled through the manure system. This clean runoff should be diverted from a manure area using gutters, curbs, dikes and terraces. Diverting the clean water helps reduce the total volume that needs to be handled as manure.

Lot runoff can be treated using vegetative infiltration areas when grassland or other land can be kept out of row crop production. A settling basin to remove solids is essential. The infiltration area can be a long, 10 to 20 feet wide channel or a broad, flat area. The runoff must travel through the vegetated area at least 300 feet before entering a stream or ditch.

Silage Leachate

Silage leachate is liquid runoff from silage piles, bags, or bunkers. The leachate that seeps out of the silage due to the weight of the silage or excess water contains organic matter, ammonia and is very acidic. It can pollute groundwater and kill vegetation where it collects. Silage leachate should be controlled to protect ground and surface water. Controls might include keeping rainfall off silage to the extent possible and controlling runoff from silage storage areas.

Land Application of Manure

Manure nutrients are typically recycled on nearby cropland where they are used by crops that are fed to the dairy herd. Nutrient management planning balances the nutrients in the land applied manure with the nutrients removed by the harvested crop. It is important to know the amount of manure produced on the farm, the nutrient content, and the nutrients required for specific crop production.

On average, a lactating dairy cow weighting 1000 lb live weight produces almost 30,000 lb of manure per year. From Table 1, a 1000 lb cow produces 82 lb per cow per day, which when multiplied by 365 days per year results in 29,930 lb of manure per year per 1000 lb cow. A 1400 lb cow produces 115 lb of manure per day or almost 42,000 lb per year (115 lb of manure per cow per day times 365 days per year divided by 2000 lb per ton = 20.9 tons per year per 1,400 lb cow).

The nutrient content values listed in table 2 are approximate and do not include bedding material or account for added water.

Table 2. Daily dairy cattle manure nutrient production, not including bedding and assuming 88% water.

Animal size (lb)	lb. nitrogen /day	lb. Phosphorous (P_2O_5)/day	lb. Potassium (K_2O)/day
150	.05	.01	.04
250	.08	.02	.07
750	.23	.07	.22
Lactating cows			
1,000	.58	.30	.31
1,400	.82	.42	.48
Dry cows			
1,000	.36	.11	.28
1,400	.50	.20	.40

Manure nutrient characteristics vary from farm to farm. To get information on each farm, the recommended practice is to collect a representative manure sample after agitation as it is coming out of storage and have the manure sample analytically tested to determine the nutrient content. The amount of manure removed from the storage is needed too. The numbers in Table 2 can be used for estimating the amount of nutrients produced per cow. Lactating cows weighing 1,400 lb produces about 300 lb of nitrogen, 153 lb of phosphorous and 175 lb of potassium per year.

Manure storage, handling and field application methods affect the amount of nutrients in the manure available for plant growth. Nitrogen is very volatile and can be lost to the air as ammonia during storage and handling. Phosphorus and potassium losses are negligible except for runoff from open lots. Phosphorus and potassium can be recovered by collecting lot runoff and applying it to cropland at appropriate rates.

The field application method impacts nitrogen loss. To minimize nitrogen loss during and after land application, it is recommended that liquid and slurry manure be injected or incorporated into the soil as soon as possible after spreading.

It is important to monitor the amount of manure applied to each field so that nutrients added do not greatly exceed the crop needs. Manure nutrients, especially nitrogen, are utilized more economically by corn and small grain crops than by legumes. Legumes get most of their nitrogen from nitrogen fixing nodules, so additional nitrogen is not usually needed. Before heavy manure applications are made, soil should be tested for fertility needs. The soil tests results for nitrogen, phosphorus and potassium can be used to adjust the manure application rate to meet crop needs.

Nitrogen in excess of crop requirements can leach through the soil in the nitrate form. Excessive nitrogen application from either inorganic fertilizer or manure can cause nitrate pollution in ground water. Phosphorus build-up also should be a concern. Runoff and soil erosion from fields with high phosphorus levels can pollute lakes and streams with the soluble phosphorus in the runoff. Avoid spreading manure on frozen ground where runoff from rain or spring thaws could pollute streams, ponds, open ditches and ground water supplies.

Air Emissions

Dairy barns, feeding centers and manure storage units can be sources of a wide variety of gas and particulate matter emissions. Some gases are odorous. Some gases, such as ammonia, hydrogen sulfide and methane can be hazardous at different concentrations and exposure times. Carbon dioxide, methane and nitrous oxide are greenhouse gases. Particulate matter that is 10 microns in diameter or less can penetrate deep into human and animal respiratory tracts.

Most odors and hazardous gases come from the animal housing, manure treatment and storage units and land application. Adequate ventilation is needed to maintain concentration at safe levels for humans and animals within buildings, rooms and enclosed spaces. Odor and gas emissions from stored dairy manure can be reduced if a natural crust forms or a cover is used. Manure storage units holding slurry with organic bedding usually forms a natural crust. Plastic covers can be installed over liquid manure storage units that do not form a natural crust.

Emissions during land application can be reduced by injecting or incorporating manure as soon as possible after spreading.

Particulate matter emission can come from dusty activities related to feeding. Particulate matter can also be generated from dry open lots. These are not common in the Midwest.

Proper Care of Dairy Cattle

Keeping Your Calf Healthy

The goal in calf management is to raise a healthy calf that develops and grows normally. Following is a description of what is necessary to house and care for a calf.

When the Calf is Born

The calf should be born in a dry, clean environment. Always use care when working around cows with newborn calves. They can be very protective of their young.

When the calf is born, make sure it is breathing normally. Remove any mucous from its mouth. You may tickle the calf inside the nostril to encourage it to begin breathing. If the cow does not lick the calf dry, you should dry the calf with a burlap bag or other cloth as soon as possible. This stimulates the calf and gets it breathing normally. It also helps prevent early chilling in cool weather.

Dip the navel cord in a 2 to 7 percent tincture of iodine. Repeat again the next day. This helps prevent "navel ill" and other infections. Feed the calf 2 to 4 quarts of colostrum as soon after birth as possible (preferably within the first hour after birth). Colostrum quality can be estimated with a colostrometer. The best source of colostrum is from tested, Johne's free older cows. Pasteurizing colostrum before feeding is recommended (it should be done by heating at 140 degrees F for one hour).

Housing the Calf

Keep the calf in an area where the temperature is fairly constant so the calf isn't adjusting to sudden changes in temperature. Put the calf in an individual pen that is dry and well bedded. If housing in an elevated tie stall, use 2 to 3 inches of bedding to prevent drafts from below.

Managing the Calf

Animal identification is critical for making important management decisions such as feeding, selection, medicating, breeding, and culling; for official production testing systems; and for registering animals with purebred cattle organizations. Animal identification may be either temporary or permanent.

Temporary identification methods include ear tags, neck chains or straps, ankle straps, and marking paints. Permanent identification methods include ear tattoos, drawings on registration papers and photographs. The most popular type of animal identification is the plastic ear tag that is easily applied by trained personnel. An additional identification is the metal ear tag the veterinarian attaches following brucellosis vaccination. More recently, electronic identification systems are being developed that use a combination of "readers" or "decoders." The U.S. Department of Agriculture (USDA) recognizes the use of the Official National Animal Identification System (NAIS) 840-RFID (radio frequency ID) tags for the dairy animal for its lifetime. Every animal should be identified by a method that is permanent and easily read by caretakers.

Next, make a permanent written record. Make sure the record includes the following:
- Permanent identification number
- Supplemental identification number if there is one
- Calf's name
- Birth date of calf
- Sire's name and number - Dam's name and number

Other data that may be kept on the record include the following
- Weight (pounds) and/or chest circumference (inches) at birth, at weekly intervals until weaning, such as at three months, six months, etc.
- Daily rectal temperature until the calf is weaned
- Daily water intake until the calf is weaned
- Date dehorned, extra teats removed, etc.
- Date and type of vaccination
- Date of observed heat periods
- Date of breeding and sire used
- Date of pregnancy test and results
- Place for veterinarian and health records

One of the first management tasks is teaching the calf to drink. Either a nipple pail or an open bucket is suitable for feeding milk or milk replacer. To teach a calf to drink from an open pail, place your fingers in its mouth. When it starts to nurse, lower its head into the pail of warm milk or milk replacer. You may need to repeat this process several times. Be consistent in feeding time and amounts fed to minimize stress. Irregular feeding times with different people feeding different amounts can cause scours in calves.

The pail must be cleaned thoroughly after each feeding. Dried milk is a good place for bacteria to grow, and these bacteria may cause a calf to get sick. First rinse the bucket in warm water, then wash in hot water with a good cleaning agent. After this, rinse with cool water containing a sanitizing agent. If many calves are to be fed at once, a separate pail for each calf is recommended. This helps reduce the chance of spreading disease. Individual pens for each calf help calves from sucking one another. The use of automated calf feeders to feed calves in groups of 10 to 20 is being adopted by some producers. The automated calf feeder automatically mixes the milk replacer or pasteurized waste milk in 1 to 2 lb batches so the calf is always drinking warm, fresh milk.

The calf always should have fresh water available. If a bucket is used, change water at least once each day. In cold housing, your calf should receive fresh water at least twice a day. Calves up to six months of age drink two to five gallons per day.

An optional practice is to remove extra teats. Extra teats can be removed as soon as you can determine which are the extra ones. If in doubt, wait. But, extra teat removal should be

performed within the first six months of life to ensure a quick recovery. Extra teats can be snipped off with sharp scissors, scalpel or emasculatome in a hygienic manner.

Another task is to dehorn or disbud the calf. One method is using a dehorning iron. This job is most easily performed when the horn buttons form at about two-three weeks of age. First clip the hair around the horn button. Be sure the iron surface is hot enough to char a piece of straw before applying to a calf's head. Apply the hot iron over each horn button for 10-20 seconds. Make sure there is good penetration all around the horn button. Exact time needed for the dehorner application depends on temperature of the iron, the amount of pressure that is being applied and the thickness of the calf's horn.

Another dehorning method is dehorning paste. Follow directions carefully when using a caustic paste. Procedures may vary from farm to farm. Following is one procedure. The hair must be clipped from each horn button. A small wire brush should be used to slightly rough up the horn bud area. To avoid damage to the calf's eyes, place a ring of Vaseline or udder balm around the base of each horn before applying the caustic. The dehorning paste is then rubbed vigorously over the horn buttons. This method is best used on very young calves but can be used up to 8 weeks of age. If done on 1 week old calves, the paste should cover an area the size of a nickel.

Vaccinate calves for necessary diseases as outlined on pages 30 and 31. Vaccinate the calf only when it is healthy and not under stress.

A calf's feet may need trimming before it is turned out on pasture, especially if the calf has been kept on bedding or in small stalls. The bottom of the feet may need shaping. Long toes that force an animal to walk on its heels should be cut back.

Minimizing Stress

Plan your management program carefully so that you minimize stress to the calves. Trying to dehorn, vaccinate for brucellosis and IBR-BVD-PI3, wean, and move a calf to a different pen all at the same time may be time efficient for you, but is very stressful to a calf's health. The spacing of vaccinations and other routine herd health procedures will minimize calf stress and help ensure good calf health.

Keeping Your Heifer Healthy

This section deals with older calves and yearling heifers up to the time of freshening. There are different housing and management needs for older animals. Some items to consider include the following

Housing and Facilities

If housing calves individually, group calves about one week after they are weaned. This allows for more efficient feeding and care. Keep each group at about the same age and size. Do not put a young calf into a group of mostly yearling heifers. The young calf may not get enough to eat because of competition. It is important to provide bedding to keep the heifers dry, comfortable and healthy. Recommended materials include straw, paper, sand, corn cobs, sawdust, chopped corn stalks, and shavings. When the weather allows exercise, provide lot space for the heifers.

Again, providing plenty of water is important. Factors that affect how much a dairy animal drinks include the animal's age, amount and type of feed consumed, ambient temperature, amount of exercise, and cleanliness and temperature of the water.

Caring for a Lactating Dairy Cow

The performance, health and welfare of the lactating cow reflect the quality of care received at every stage of the production cycle. The welfare and care of the modern lactating cow are critical for the success of the dairy farm and for providing the consumer with quality dairy products.

Facilities

Proper facility design reduces stress and provides for comfort, proper nutrition, and health of the lactating cow. Temperatures under 40°F may adversely affect lactating cows. Cold stress symptoms in dairy cattle are difficult to observe. The cow adapts to the stress of cold weather by increasing appetite and diverting energy from milk production to maintaining body heat. A heavier winter coat also helps the animal adapt.

Rain and fog do not directly harm the cow. However, mud in lots can increase the risk of mastitis; frozen, crusty mud may injure the teats and udder. Also, cows traveling in mud can increase the body maintenance nutritional requirements by 20 to 50 percent.

Cow productivity also can be decreased by temperatures over 75°F and is aggravated by increasing humidity with high temperatures. The heat-stressed cow eats less resulting in reduced production. Stress signs such as panting or standing in water are not obvious until prolonged exposure to extremely high temperatures or humidity occurs. Heat stress is compounded when the temperature does not fall below 70°F at night.

Feed and Water

Each cow should receive a balanced ration that meets her nutrient needs. Body condition of cows should be evaluated regularly so feeding and management practices can be appropriately altered. The feeding section on pages 26 and 27 outlines dairy cow nutrition.

Dairy cows need fresh drinking water for normal growth and production. A dairy cow consumes about five gallons of water per gallon of milk produced daily. Cows should have easy access to water and there should be sufficient waterers (number, size, capacity) to accommodate all animals in a pen or lot. Cows are sensitive to water problems because of the large volume they drink. Excess nitrate, salt, bacteria, algae or chemicals can decrease water consumption and cause adverse health effects. High water quality is vital. In addition to testing water for nitrate and salt level, simple management practices such as cleaning water troughs is important.

Foot Care

Healthy feet are important to the productive cow. Lameness will interfere with movement to the milking facility, obtaining feed and water, exhibiting estrus, and general health. Therefore it reduces milk production and is a major welfare problem. Foot rot, a foot condition caused by a bacterial infection, can cause severe discomfort for the dairy animal and be a source of economic loss to the dairy. The first sign of foot rot is lameness that may involve one or more feet. In acute cases, lameness is followed by swelling of the foot, spreading of the toes, and an abscess above the hoof. If not corrected, the infection will spread deeper and infect the joints, resulting in chronic arthritis. Other common hoof lesions in dairy cows include sole ulcers, whiteline disease, and digital dermatitis (hairy warts).

Hooves should be trimmed at regular intervals by a trained hoof trimmer. Cows should be kept off rough or slippery surfaces. Proper drainage of all locations to minimize standing water also helps. Early detection and treatment will help minimize the incidence of foot disorders. Various types of foot bath solutions may be used to decrease the incidence of some foot diseases, such as foot rot and hairy warts.

Dry Cow Care

A "dry" cow is a cow that is not producing milk (lactating). Daily milking is usually ceased abruptly after a dairy cow has been lactating for 10 to 12 months. The dry period ideally begins 40 to 60 days prior to the next calving.

The dry period allows for the regeneration of milk secretory tissue in the udder. This process takes three to four weeks. Cows that are not given an adequate dry period will produce less milk in the subsequent lactation. A dry period of more than 70 days can contribute to obesity at calving. Obese cows are likely to have more calving difficulties and metabolic disorders.

Health Care and Management

Cows recently turned dry should be carefully monitored until their udders no longer produce milk. Cows developing hard, swollen quarters should be milked out. This will remove the bacteria responsible for the inflammation. Approximately half of all new mastitis infections (infection of the mammary gland) occur in the dry period, with most occurring immediately after dry-off. Cows are particularly susceptible to new infections when milk is present in the udder. So, it is important to keep dry cows in clean housing. Dry cow therapy is an important component of a mastitis control program because it reduces the number of persistent teat infections and new dry period infections. Use of external or internal sealants (such as Orbeseal) is also recommended during the dry period to reduce the risk of infection.

Dry cow therapy consists of infusing each quarter of the udder using a registered, Food and Drug Administration approved, long-lasting antibiotic at the end of a lactation. It is most beneficial if all four quarters undergo treatment at the end of each lactation. If the herd's level of contagious mastitis is low, the producer and the veterinarian may consider treating only cows that have a record of mastitis infection or high somatic cell counts.

Dry cow therapy has several advantages over treatment of mastitis during lactation. During the dry period, higher drug dosages can be used safely, the cure rate is much higher, and the risk of milk contamination from drug residues is reduced. A sterile individual syringe always should be used to avoid introducing infectious organisms into the udder.

Always read and follow the manufacturer's label instructions. Observe withdrawal times to avoid residues in meat and milk.

Dip teats in a safe, effective teat dip before and after treatment. Immediately after administering dry treatments, the cow should be removed from the milking string. Cows should be observed for any complications for seven to ten days after treatment.

Other health treatments may be administered at this time, depending on local disease problems and specific herd problems. Any necessary vaccinations should be scheduled well in advance of calving to allow the accumulation of desired immunoglobulins in the colostrum. Cows with diagnosed parasitic worm infections also can be treated during the dry period. Directions should be followed carefully on all vaccines. Some drugs can cause abortion.

General Care Guidelines for All Dairy Animals

Treatment Facilities

A hospital pen is recommended for the dairy to isolate and treat sick animals. Locking stanchions make observation and treatment easier. All calves should be observed daily and sick or injured calves treated promptly.

Parasite and Fly Control

Flies breed readily in a moist, warm climate. Bedding and accumulated manure make a great environment for fly breeding. Flies can be a significant stress on young calves. Control should be based on destruction of fly larva habitat by moving calf hutches frequently and removing accumulated bedding and manure. Fly larvae and pupae also live in manure, especially in relatively undisturbed areas such as weedy fence lines, around water troughs, and behind stanchions. Some species of flies breed in piles of straw, hay, and other organic debris.

Keeping a farm neat and clean and removing manure from under fences and behind stanchions can help reduce fly numbers. Insecticide dust bags in lots help keep adult flies off calves. Spraying with approved insecticides can temporarily reduce the number of adult flies.

Chemical control of flies should not be the sole method of fly control. All labels should be reviewed before using chemicals because there are various milk and meat withdrawal periods. Certain chemicals must not be used on calves less than three months of age. Also, obtain your state's latest pesticide recommendations, which can be obtained from your county extension agent.

Heifers housed only in dry lots do not require deworming. Heifers kept on pasture should be dewormed on a schedule that is designed for local climatic conditions. Purchased heifers of unknown origin should be dewormed at least once prior to calving.

Dairy Industry and Cooperative Structure

What is the dairy industry? In numerical terms, it is one of agriculture's largest employers with close to one million people involved in 2010. Along with dairy producers and processors, there are many others who are part of this complex web that supplies consumers with nature's most nearly perfect food. Equipment dealers, veterinarians, nutrition consultants, and milk haulers are examples of important industry support personnel.

Over the last 40 years, the dairy industry has been shifting geographically. California surpassed Wisconsin as the leading state for milk volume produced, and states in the western and southwestern United States have shown marked growth. These shifts can be attributed to more favorable climates, lower housing costs, and shifting population centers. The trend is definitely toward larger but fewer herds and higher producing cows.

Top 10 Dairy States in 2019

State ranking-total milk production	State	Total milk production (in millions of lbs)	Number of cows (in thousands)	Milk per cow (lbs per year)	Number of licensed dairy herds	Average herd size
1	California	40,564	1,726	23,502	1,255	1,255
2	Wisconsin	30,601	1,267	24,152	7,720	165
3	Idaho	15,631	625	25,010	460	1,324
4	New York	15,122	627	24,118	3,880	161
5	Texas	13,850	565	24,513	380	1,413
6	Michigan	11,385	426	26,725	1,330	319
7	Pennsylvania	10,108	490	20,629	5,730	92
8	Minnesota	9,931	448	22,167	2,730	166
9	New Mexico	8,187	326	25,113	140	2,357
10	Washington	6,783	280	24,225	370	749

USDA, 2014 Dairy Statistics

US Dairy Industry Continues to Consolidate

Year	All U.S. licensed herds	Change in herds	1-99 cows	100-199 cows	200-499 cows	500+ cows
2000	82,937	-4,590	62,102	12,835	5,340	2,660
2001	76, 875	-6,062	56,650	12,255	5,175	2,795
2002	74,110	-2,765	54,655	11,555	4,990	2,910
2003	70,375	-3,735	51,665	10,980	4,765	2,965
2004	66,830	-3,545	48,675	10,445	4,700	3,010
2005	64,540	-2,290	46,750	10,055	4,662	3,073
2006	62,070	-2,740	44,600	9,760	4,567	3,143
2007	59,130	-2,940	42,440	9,011	4,359	3,320
2008	57,127	-2,003	41,127	8,700	3,950	3,350
2009	54,942	-2,185	39,142	8,600	3,850	3,350
2018	45,344		21,060	**100-499 cows:**	10,587	3,464

Likewise, consumer preferences have changed over time. People have been buying less fluid milk while cheese consumption has increased dramatically Consumption of butter has increased slightly over the last ten years. Consumer preferences have a major effect on supply and demand of various products, and these often are determined by perceived nutritional and health benefits.

Economically, the dairy industry is huge. The dairy industry is structured around cooperatives that market about 86 percent of the country's milk as it leaves the farm on its way to processing. About 155 dairy cooperatives in the United States handle products valued at over $44 billion. Other ways that milk can be marketed include individual producer processing, state milk commissions or control boards, and federal milk marketing orders. Many times these methods overlap. For example, milk marketing cooperatives frequently operate in federal orders.

The milk price a dairy producer receives is determined by several factors. Determining this milk price is a complicated process. Dairy producers are paid for actual pounds of protein and butterfat shipped from the farm. There also are some processor quality incentives. The price for protein and butterfat is determined by how the milk is used; whether it goes to fluid milk, cheese or butter. There are currently four classes of milk utilization: Class I is fluid milk, Class II is soft products like yogurt, ice cream, and sour cream; Class III is cheese and Class IV is butter and non-fat dry milk.
Federal marketing orders were authorized by Congress in 1937 and have functioned to set prices paid by processors to producers. This helps develop a stable milk market for

consumers and helps insure an adequate supply of milk at fair prices. In 2020 there are 11 Federal milk marketing orders or pools which are defined market areas in the country which use the four classes of products to calculate the price for that order.

The dairy producer's main legislative voice is the National Milk Producer's Federation (NMPF). This organization provides input in developing policies affecting the dairy industry. In addition, worldwide forces will influence U. S. markets through trade agreements such as the North American Free Trade Agreement (NAFTA), General Agreement on Tariffs and Trades (GATT), and future developments.

Over the past 40 years there has been a steady increase in manufactured milk products, especially cheese. Cheese consumption per person in the US has increased 50% for American and processed cheese and over three times for other cheese; especially Mozzarella used on pizza. Butter consumption has held steady over the years. How milk is used varies across the country. More of Minnesota's and Wisconsin's milk goes into making cheese while out East, more is used as fluid milk due to higher populations in that area.

Cooperatives

Because so much of the nation's milk is handled through cooperatives, let's look more closely at their role in our lives. Did you know that nearly one out of every three Americans belongs to a cooperative? Chances are that most 4-H families are part of at least one such organization. Many time youngsters do not even realize that they are part of a cooperative system. Cooperatives help the economy run efficiently, and they provide many services to their owner-members. In the United States, there are over 3,000 agricultural cooperatives with over four million members. These cooperatives employed over 172,000 employees in 1991. Their combined net business volume in 2000 was over $100 billion.

Cooperatives are businesses where the members who own them also are the people who use their services or buy their products. They differ from other corporations because their owners, the members, are more interested in the products or services provided by the cooperative than in the business' direct profits. Net income is returned to members based on use of the cooperative or patronage. However, most people don't join cooperatives to make large profits. Instead, they want to use the goods and services the organization offers.

Types of Farm Cooperatives

Marketing Cooperatives

Most dairy products are handled through marketing cooperatives. These organizations allow members to have a voice in the distribution and sale of commodities. In the case of milk, this includes the manufacture of products and delivery to stores. About half of the country's agricultural cooperatives are marketing organizations. One of the most important roles of marketing cooperatives is developing broad outlets for farm products. Through advertising and other promotion, dairy products are visible in many televisions shows, at baseball games, and other events. A "checkoff" system finances dairy advertising, research, and education. This is a nationwide promotional effort financed by producers to increase demand, educate consumers, and develop new dairy products. Usually the checkoff is administered through the producer's marketing cooperative.

In 2012 dairy cooperatives accounted for about 3/4 of all butter and a quarter of all cheese marketed in the U.S., and about 2/3 of the U.S. milk supply is handled by the 20 largest organizations. The nation's two largest dairy cooperatives in 2020 were Dairy Farmers of America (DFA) and Land O'Lakes. DFA has members in over 30 states from coast to coast and became the largest organization through mergers with several small cooperatives. Mergers are an increasing trend in cooperatives because they can increase financial efficiency and expand goods and services available to members.

Dairy cooperatives are just one example of an agricultural commodity involved with cooperative marketing. Almost every farm product has a marketing cooperative somewhere in this country. Many of these have established well-known retail brands and totally control their products from producer to consumer. Famous names include Sunkist, Ocean Spray, and Blue Diamond.

Supply Cooperatives

Supply cooperatives are the second major cooperative type. While marketing cooperatives primarily work to increase producer income, supply cooperatives typically function to reduce producer costs. This is accomplished by bulk purchasing and distribution of products required by member-owners. In 1991, supply cooperative business volume was $17.9 billion.

These organizations provide a steady supply of farm necessities at competitive prices. Examples of these inputs include feed, fertilizer, and equipment. An example of a supply cooperative is Land O Lakes/Purina feed and Cenex/Harvest States. Others include Farm Bureau and Countrymark. There are also many local supply cooperatives in various areas of the country.

Service Cooperatives

Service cooperatives are similar to supply cooperatives, except that they provide more specialized services instead of tangible goods. Several major types include credit, utilities, specialty services, and insurance. An example of a credit cooperative is Farm Credit, a national group that provides financial services to farmers and ranchers. The Farm Credit System was originally authorized by Congress and has been providing both long-term and short-term loans since 1916.

Specialty service cooperatives are among the most visible in the dairy industry. Artificial breeding cooperatives supply members with high-quality semen, outstanding genetics, and

professional artificial insemination services. Examples include Select Sires, Genex/CRI, Accelerated Genetics and others. Dairy Herd Improvement Association (DHIA) cooperatives are responsible for accurately supplying production records and management information to dairy producers. Outside the dairy industry, two well known specialty service cooperatives include the Associated Press (AP) and Florists Telegraph Delivery Service (FTD).

Breed associations were originally established to record identity and parentage of animals. Since then, their role and services have increased. Breed associations often resemble specialty cooperatives because they are controlled by a board of directors elected by members but are actually non-profit organizations. The board then hires management personnel.

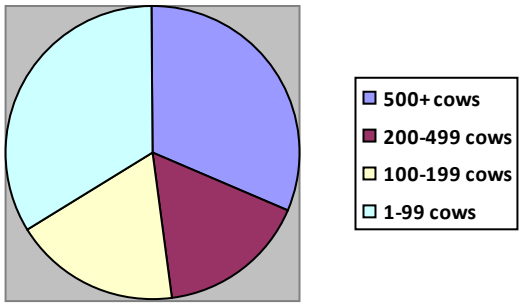
Summary

The United States' dairy industry is large and complex. Cooperatives play a central role in milk marketing and supplying inputs to producers. Shifts in geography and consumer preferences have led to many changes in the dairy industry, and increased attention to world markets will lead to more adjustments. Future milk prices are likely to be determined by dairy supplies and consumer demand on both a national and international scale.

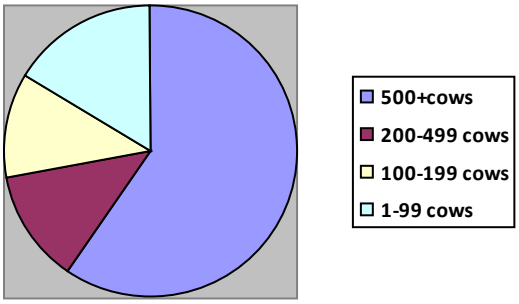
Top 10 Markets for U.S. Dairy Exports

Rank	Country	2019 Exports (in millions of dollars)
1	Mexico	1,531
2	Southeast Asia	928
3	Canada	807
4	China	373
5	South America	368
6	South Korea	332
7	Japan	282
8	Middle East and N. Africa	274
9	Oceania	253
10	Caribean	234

2000



2009



Milk per cow (2019)

Average annual milk production per cow (lbs of milk)

Top 5

Michigan	26,725
Colorado	25,844
New Mexico	25,113
Idaho	25,010
Texas	24,513

Average herd size

(Number of cows per herd)

Top 5

New Mexico	2,357
Arizona	2,311
Hawaii (1 herd)	2,000
Nevada (20 herds)	1,600
Colorado	1,467

Dairies lost from 2013-2019) in major dairy states

Top 10 for % lost	# dairy lost	% lost
Missouri	-490	38.0%
Michigan	-700	34.5%
Indiana	-450	34.2%
Ohio	-990	33.8%
Minnesota	-1135	29.4%
Wisconsin	-3140	28.9%
Iowa	-410	27.2%
Vermont	-250	26.9%
New York	-1160	23.0%
Washington	-110	22.9%
US Total	-12,788	27.2%

Careers in the Dairy Industry

"What do you want to be when you grow up?" is one of the most common questions asked to youngsters. It is interesting to watch the answers change as students progress throughout their high school and college years. Very few times does a person have the same career aspirations at the beginning of elementary school as at the end of their college experience. This is because a person's interests change, careers change, and circumstances change. Many times students prepare for a particular career, only to find that there are no openings when they are ready to enter the job market. Likewise, some of the most exciting career opportunities today did not even exist ten years ago. Flexibility is the key to successful career preparation.

Agriculture continues to thrive and grow, and the supply of available workers cannot keep up with this demand. Not enough talented persons in the food and agricultural sciences are being trained to fill openings in business, science, and resource management. Because of these statistics, the future for employment in the agricultural sciences, and in particular the dairy industry, looks brighter than ever.

What types of jobs are available?

In the 2007 census conducted by the United States Department of Agriculture, two to three percent of the population is directly employed in an agriculturally based career. Areas that are growing most rapidly include food; animal medicine; education and biotechnology. However, there continues to be a shortage of quality workers in almost all sectors of agriculture.

Agribusiness based work has been an area of fast growth. Major employers include agricultural supply firms, A.I. and breed organizations, pharmaceutical companies, and dairy marketing organizations. Persons in these careers need to be highly motivated, well-organized, and possess excellent interpersonal skills.

Another major employment category includes scientists and engineers. Some dairy-related careers that fall under this grouping are veterinarians, geneticists, nutritionists, and quality assurance specialists. Major employers include A.I. organizations, milk processors, and feed companies. As environmental regulations continue in this country in relation to agriculture enterprises, an increasing number of opportunities will be available in nutrient management and water quality control. These jobs involve more technical expertise and training than most, and many require advanced degrees beyond a basic four year bachelors.

Financial managers and specialists are another area expected to show growth. Farm supply firms, banks, government agencies, and extension programs will employ many of these professionals as economists, credit analysts, and other management personnel. Social service positions also have been increasing. Examples of these jobs include food inspectors, peace corps representatives, and veterinary medical assistants.

Communication and education specialists are playing an increasingly important role in agricultural enterprises. Public relations representatives, computer software designers and educators, and journalists are important to keep organizations running smoothly. As mentioned previously, there are currently more graduates than positions available in these fields.

Although most people may think of production specialists as one of the largest employment categories in agriculture, less than 10 percent of future opportunities are expected in this area. Examples of production specialists include herdspersons, feedlot managers, and aquaculturalists. Economic pressures in the dairy industry will mean fewer but larger production operations, but managers will be expected to be more educated in the areas of computers, labor management, and record-keeping.


Photo courtesy Midwest Dairy Assn

What qualities are valued by employers?

A Michigan State survey of employers ranked relevant work experience first in credentials for employment of college graduates. These experiences often take the form of farm experience, internships and summer jobs and are important because they show that the candidate has been exposed to the real world of work. Many college students complete agriculturally-related internships and later receive job offers because of their positive internship experiences. One area of work experience often overlooked by students is involvement on the family farm. In fact, some fail to even list this on their resume. Employers like farm experience. They associate this with responsibility and ability to relate to an agricultural clientele. According to many career resources, employers are increasingly hiring persons with more than one internship experience.

Also ranking high in the Michigan State survey was grade point average. Solid grades are a good indicator that the candidate can master subject matter easily, and employers use them as a screening mechanism. For high school students, grades are a tool used by colleges to make admission decisions. Students that combine good grades with excellent activities are always in high demand.

In the changing nature of employment, one skill that ranks much higher than before is ability to collaborate. As the economy has shifted to a service base, working in teams to satisfy consumers has become more important. On many farms, working relationships between the producer, veterinarian, financial institution, and/or nutritionist have become routine. Likewise, in many companies, teamwork between technical consultants and sales staff is essential for success in solving problems.

How does one show an ability to collaborate? Many 4-H activities such as serving on committees, holding offices, and planning activities show excellent teamwork. Working together in class projects, debates, and case-decision studies are good ways to develop this team approach. More fun ways to display teamwork are to become involved in judging and dairy quiz bowl teams. These demonstrate that members can work together for a common goal, and such activities also offer positive networking opportunities. Networking is critical in searching for employment today. One employment counselor states that finding jobs in today's world is "like being a private detective:" Large companies are no longer doing the majority of hiring. Industry contacts made through clubs, judging teams, volunteer work, and summer internships greatly enhance the likelihood that a student can discover career opportunities in the smaller companies that only hire one or two employees per year.

Other candidate traits receiving high priority by employers are knowledge of quality (TQM), computer literacy, and customer orientation. Many of the best newly available jobs are working directly with customers. Understanding their needs and limitations is critical for success. That is why employers look positively on candidates who have experience, even if it is working in fast-food restaurants or convenience stores. These jobs demonstrate capabilities to relate to customers and to work in teams.

Finally, some companies list willingness to relocate as a major qualification. If a candidate has rigid geographical restrictions, employment opportunities are greatly reduced.

How do I find a career?

Deciding on a career takes time, effort, and sometimes luck. However, chances of success increase greatly with proper preparation. The first step in identifying possible opportunities is deciding what type of work you want. Employers like candidates who are focused and know their strengths. Do you want to work for a large company or a small business? Would you want to be a herdsperson for a 50-cow farm or a 2500-cow operation? Do you need to live close to home, or does traveling excite you? Ask these sorts of questions when assessing your career goals.

Everyone has things they like to do. Make a list of your favorite tasks. Likewise, list things that you definitely would like to avoid. After you have completed this step, interview people in positions that are interesting to you. Your veterinarian, nutritionist, and extension agent might be good places to start investigating careers. Your guidance counselor also should be able to suggest possible career opportunities. However, many counselors are not familiar with many of the exciting careers in the agricultural sciences.

You probably will discover that for some of your career choices, you will need a baccalaureate or more advanced degrees that involve graduate work. For others, you may only need a high school education or an associate's degree.

Choosing a good school to prepare for your career is a key step towards future employment. When selecting a college, be sure to visit the campus and schedule appointments with faculty members if possible. Also try to meet students enrolled in your potential field of study. All of these people can be excellent sources of information. Tuition and scholarships may be a factor in your decision, but think of your college career as an investment, not an expense. When evaluating colleges, also be sure to investigate work opportunities on campus, extracurricular activities, and advising and placement services.

Along with making college decisions, it is important to obtain relevant work experience. Often this involves applying for positions and preparing a resume. Likewise, if you are applying for work directly out of high school, a resume can be a helpful tool. Even if you are not currently applying for a position, preparing a resume can help pinpoint areas you may need to strengthen to be competitive in the job market.

Preparing a resume

The purpose of a resume is to help you get a job interview. You need to demonstrate through the resume that you have the skills and experience necessary to be a qualified job applicant. Although resume formats vary, several key elements are usually included. Keep in mind that a resume should emphasize your strong points.

The first important category is your name and address. If you are in college, include both a permanent and school address. Also be sure to list phone numbers where you can be reached easily. The second major category is career or job objective. This should be clear, concise, and not too general. Here are some examples:

- To use my superior dairy industry knowledge in a challenging position. (too general and arrogant)
- To use my previous farm experience in a summer position on a registered Holstein farm. (good)
- To work with people in a challenging career. (too general)
- To use my agricultural business education in an entry-level credit analyst position. (good)

Another major category is education. Many young people only list their high school and date of graduation. If they have college experience, this is probably acceptable. However, if they have just completed high school and are searching for employment, then this may not be complete. Contrast the two examples below from applicants searching for a herd manager position. Which would you hire?

(A) Education
Graduated from Honesdale High School, May 2010.

(B) Education
Honesdale High School, May 2010.
Graduated in agricultural business curriculum.
Relevant courses: Advanced Accounting
Business Management Animal Science
Twin-States A.I. School, July 2010.
Learned to inseminate cows and detect heats.

A fourth major resume category is work experience. This is a major item that employers will consider. Most readers expect your most recent experience to be listed first. Give details of your accomplishments when possible, and include facts that are relevant to your career objective. Below is a good example for a 4-Her seeking a herdsperson position.

Notice the "action verbs"-managed, implemented, organized, supervised. These concisely convey the importance and impact of the experience. Other good action verbs include words such as negotiated, developed, interpreted, controlled, presented, conducted, evaluated, and taught.

John Doe Dairy Farm *June 2010-July 2010*
- Managed young calves; reduced calf mortality by 20 percent
- Implemented head detection system that reduced serviced per conception from 3.2 to 1.9 services

Franklin County 4-H Fair *May 2010*
- Organized and supervised 20 members selling ice cream; club raised over $1500

Finally, a fifth major category often included is activities. Sometimes honors and awards also are listed. List the most relevant and important activities first. Emphasize activities and awards that support your career goals.

Examples: Central FFA – Vice President, Treasurer

Wayne Holstein Club Outstanding Member – 2009

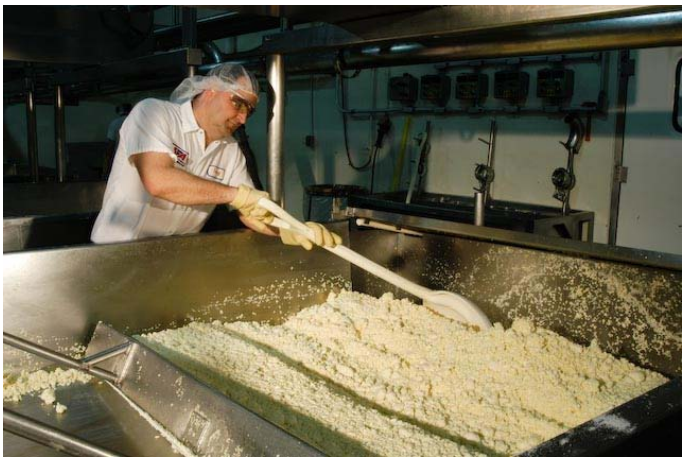
Wayne County 4-H Council – Membership chair
- Increased attendance 25% in 2010

These are the major categories included in most resumes. For most young people, one page is usually enough to convey their experiences. Be sure that there are no misspellings on the resume and that it is easy to read. If you are not sure whether to include something, put yourself in the employer's shoes and consider what might be useful to him or her. Constant proofreading and editing are keys to successful resumes. Have other people review your efforts and offer suggestions.

When you obtain an interview, be sure to take extra copies of your resume along. Also expect to answer questions about any items listed, especially work experience and activities. Before the interview, try to obtain information about the company or farm so that you will have questions for the interviewer and also have a good understanding of what the interviewer may be looking for in an employee. Also send a thank you note to the interviewer after your appointment.

Summary

There are many jobs in the dairy industry for qualified individuals. Demand for applicants is high, especially in sales and service positions. Employers are looking for candidates with relevant experience and good interpersonal skills. When deciding on a career field, you should determine skills that you enjoy and then investigate possible careers using these abilities. Often interviewing people in the field is a great way to learn about a career. Internships and extracurricular activities also can help you learn more about a job or company. Preparing a resume is a crucial step in obtaining employment, and editing and proofreading are essential to developing a strong resume.



Photos courtesy Midwest Dairy Association

Dairy Farm Systems Management

It is unlikely that anyone today would look at dairy farming as an easy occupation, but there may still be people who look at it as a fairly simple set of tasks: get up in the morning, milk the cows, feed the cows, clean up after the cows, and milk the cows again in the evening. That sounds pretty straight-forward. In reality, it is a great deal more than feeding and milking a few cows. Dairy farming today is a complex set of sub-systems that fit together to build a successful dairy business for the person or people willing to put the necessary work into it.

Among the dictionary definitions of a "system" are the following:

1. *A group of interacting, interrelated, or interdependent elements forming a complex whole.*
2. *An organized and coordinated method; a procedure*

These descriptions fit a dairy farm very well. A smooth dairy operation has many different elements, each of which must work in coordination with the other. Sometimes these systems will all be in one location, and sometimes they may be separated with different locations and managers, but they still need to be coordinated to make the total dairy farm system work.

Here is a sample list of the systems that might be found in one dairy business.

- Feed production
- Feed storage
- Feed preparation and delivery
- Breeding
- Calving
- Fresh cows
- Milking cows
- Calf-raising
- Heifer raising
- Dry cow management
- Manure handling, storage and management
- Marketing
- Mortality management
- Workforce management
- Animal Housing
- Record-keeping
- Machinery systems

Under each of these major categories there might be several sub-systems that need attention. These are just some of the systems that are more readily seen and need to be addressed. Each of these systems needs to work in cooperation with the others on the farm. For example, if you do not have a good calf and heifer management system in place, you could very easily find yourself short of replacement heifers needed to maintain your herd size within two years.

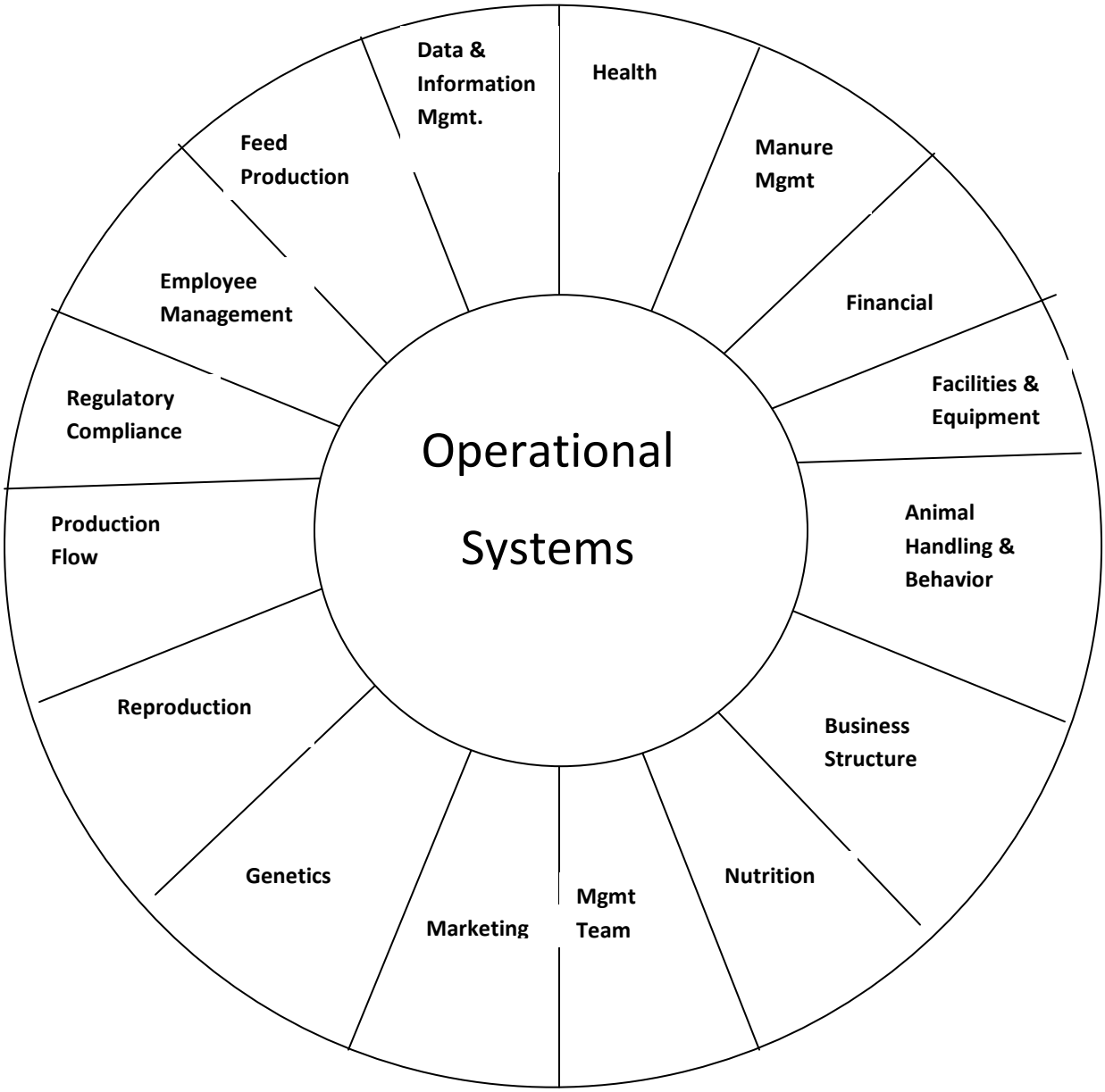
Another example might be feeding the cattle. It sounds simple, but if you look deeper you need to decide what feeds will be fed? Will it be grown on the farm or purchased? Will forages be grown, harvested and stored or will you use a grazing system? What about the machinery and land for feed production? How will it be prepared and delivered to the stock? A breakdown in any of those sub-systems can mean inadequate or no feed to the cattle at some point in time.

<u>Not</u> on this list are the planning and basic management tasks for the dairy. Planning and basic management systems that need to be considered for a dairy farm include:

- Financial resources and management
- Business organization/structure
- Management team
- Farm advisors

This whole relationship may be best illustrated as a wheel. Each segment of the total system is important, but only when they are all put together around an operational system or a total management system, will the business roll ahead. Not considering an element leaves a gap that weakens the system.

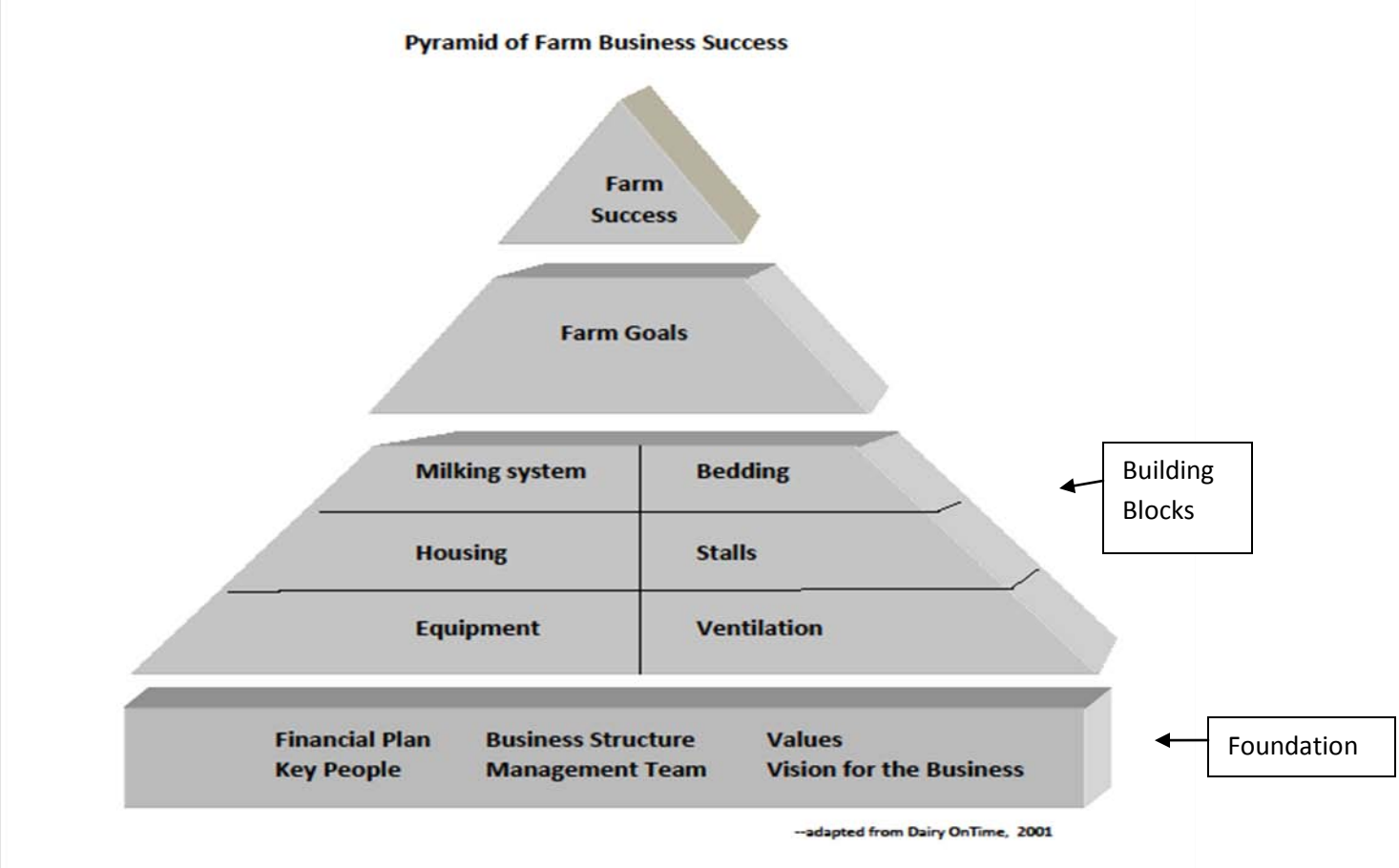
Animal Production System



Each of these represents a part of the farm's total system. Until these decisions are made and put into place, all the individual systems have little value. This foundation of the dairy business determines whether or not the farm stands a chance of success.

Lay the Foundation, Then Build the Dairy Farm

It is very tempting to begin a dairy plan with decisions like the "building blocks" in the illustration below. Those elements are often the first things thought of because they can be seen and held. While those elements are important, it is more important to lay a good foundation for your business first. Having sound foundation subsystems in place first will increase the likelihood the rest of the farm will come together and operate successfully in the future.



It is essential the business identify its key people early. These are not only the operators, but also those people who fill key roles in the day to day operation and those whose input is used for day to day decisions on the farm.

A successful farm needs a vision for its business and values that guide all its decisions, keeping the farm moving in a direction. The farm should take advantage of outside advisors as part of a management team who can see things on the farm that may be missed by those on the farm every day. And finally, a solid business/financial plan will help explain the business to others who will be necessary to help finance most businesses.

Navigating through this maze of subsystems to make up one solid dairy system makes an education more important than ever. Education can take several different forms, but probably its most important part is exposure to different ideas and learning to adapt appropriate ones to your farming situation.

The education may be four-year degree, or a technical training and business management degree from a technical college. It might be an apprenticeship and experience on another business or farm where you benefit from the guidance of others. An education puts you in the position as the keystone of your farm's system.

Key Points:

- **A farm consists of many interrelated sub-systems, each of which must be in place to support the whole farm.**
- **A solid plan and key people make up the foundation of a successful farm.**

Workforce Management on the Dairy Farm

Workforce management is an important issue on a dairy farm regardless of the size of the farm. On a large farm with several employees, this is quite obvious, but even a small farm operated by the owner and family members needs to be sure it is making the best possible use of its labor resources. If the labor available is not being well used, it can greatly affect the profitability and sustainability of the dairy.

Why Employ Others?

Sometimes, even a small farm can benefit from having some hired labor in its total workforce. The decision to hire outside help has economic and non-economic benefits to consider.

Economic Benefits:

- Increased operational efficiency
- More time for marketing, pricing and financial activities
- Increased likelihood of completing tasks on time
- More efficient use of capital and overhead
- Increased production for profit
- More opportunities for growth

Non-economic Benefits:

- Reduced stress and pressure
- Increased flexibility of time for leisure, health family activities, etc.
- Safer work environment may be created by better trained employees

What Do I Need?

Many questions need to be asked as decisions about workforce are made. It is important to understand what the exact needs are on the farm and to evaluate how those needs can be best addressed. Questions should include:

- What type of help do I need?
    - Short term employee(s) for specific tasks?
    - Part-time help on a regular basis to specific duties or multiple duties?
    - Full-time, seasonal employees for peak workload times?
    - Permanent, full-time employees for a wide range of duties or specific duties?
- Is there sufficient cash flow to support extra labor?
- Will the farm have a job that keeps the interest of a motivated employee?
- Will there be a payback to the farm for the extra labor?
- What type of employee will be best suited for the job?

If the answers to these questions lead one to the conclusion extra hired labor would be a benefit, you are well on the way to making the decision to be an employer.

A second part of this discussion determining how much more labor is needed on the farm. A labor needs assessment will help determine the amount of extra labor you may need on the farm, and the necessary qualifications that workforce must bring to the farm. A thorough analysis considers the need for part-time or full-time help; whether help needs to be full-time or part-time; or even whether the farm might be better off contracting with others for specific tasks and not having a farm employee at all. The thing to remember is that not all hired labor needs to be full-time.

Being an Employer

"Being an employer" is a phrase that is uncomfortable for many farmers. Most farmers are in the business because they like it and they have become good at it. They tend to grow in their businesses because they are good farmers, but being an employer is a different job than they have usually prepared to hold. Being an employer involves a new set of skills that must either be natural or learned. As a potential employer, a farmer should ask him or herself the following questions:

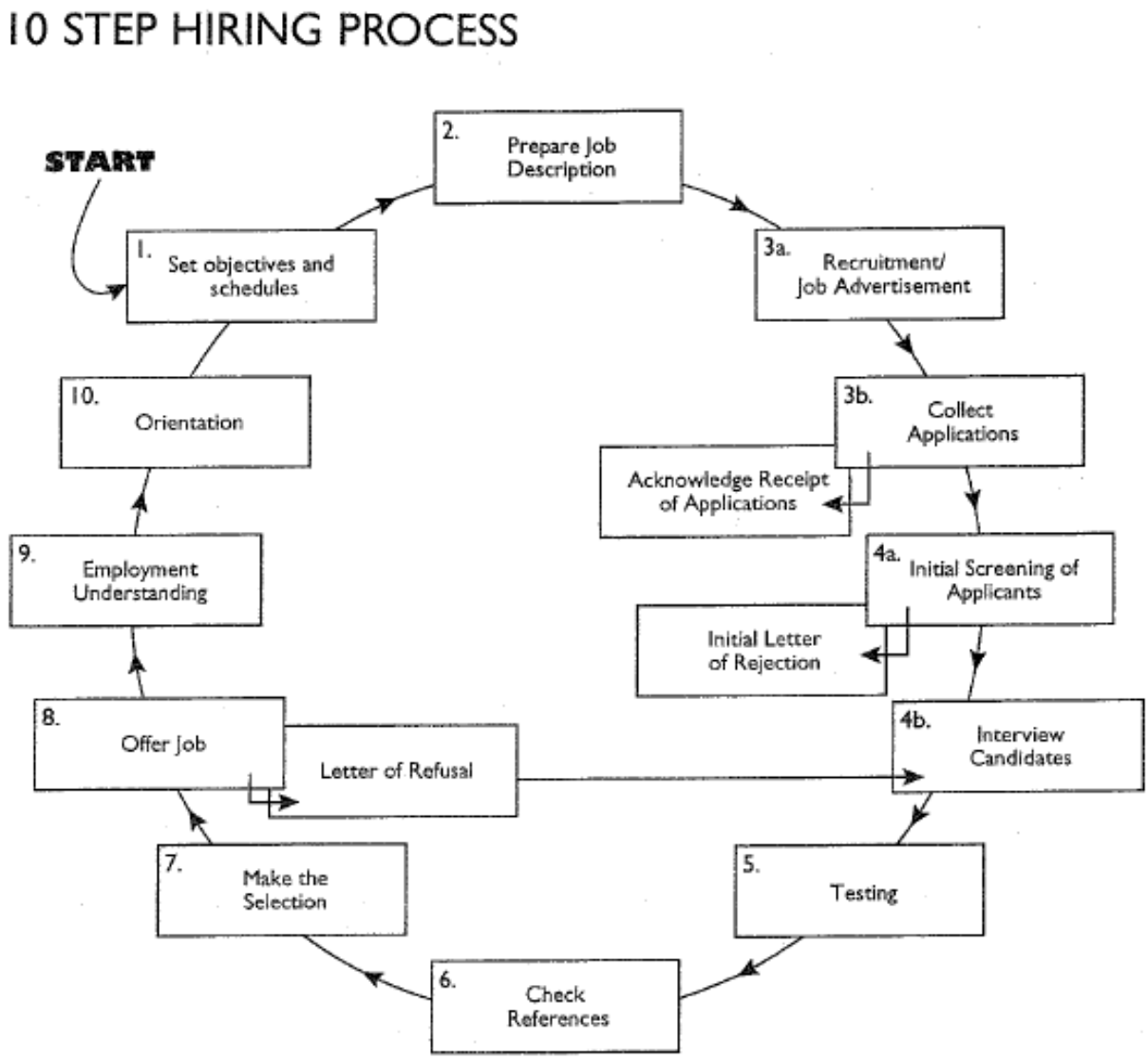
1. What are my strengths and weaknesses?
2. Am I a good teacher?
3. How am I going to develop and train staff?
4. Do I have patience to work with [people with no farm background or little farm experience?
5. Am I a good listener?
6. Do I trust my employees?
7. Do I have any biases that might get in the way of developing a good relationship with employees? (tobacco use, alcohol, politics, race, religion, etc.)
8. Am I a perfectionist?
9. Do others respect and like me?
10. Do I tend to be a pessimist or an optimist?
11. Do I delegate well?

How one answers these questions will have a significant impact on whether they should be an employer/supervisor or whether they should find someone else to conduct those functions on the farm.

Hiring Process

Hiring one or more employees is much more than putting an advertisement in the newspaper or on the local bulletin board. A good hiring process helps hire the "right person for the right job" in the first place, and can help avoid many problems later with an employee you would rather not have on the farm at all.

The following ten-step process is one example of how a far would be advised to hire employees. There are other variations of this process available, but most will be quite similar to this.



The first two steps are probably the most important. You need to know what you want to accomplish on the farm by having an employee and then one must accurately describe and communicate that need to prospective employees. A well written job description will help sort out potential candidates and help you evaluate those candidates. If a job description is too vague or broad, almost anyone could fit it and you may end up hiring an entirely inappropriate candidate for the job. Taking adequate time to complete this task will be time well spent.

After candidates have been identified and schedule for interviews, be sure all candidates are asked the same questions, and know clearly what questions can or cannot be asked. There are questions that are determined to be potentially discriminatory and cannot be asked of any candidate.

Some employers like to give candidates a hands-on test, having them perform some of the typical tasks they would be doing as an employee. This helps determine their understanding of the job, their skill levels, and their comfort level around equipment or livestock. Remember to stress safe practices if you use this technique.

Starting New Employees

Once a new employee has been hired, a whole new process starts. The ultimate success or failure of an employee hinges heavily on how well a new employee is orientated when they start work, and the training/supervision they receive later.

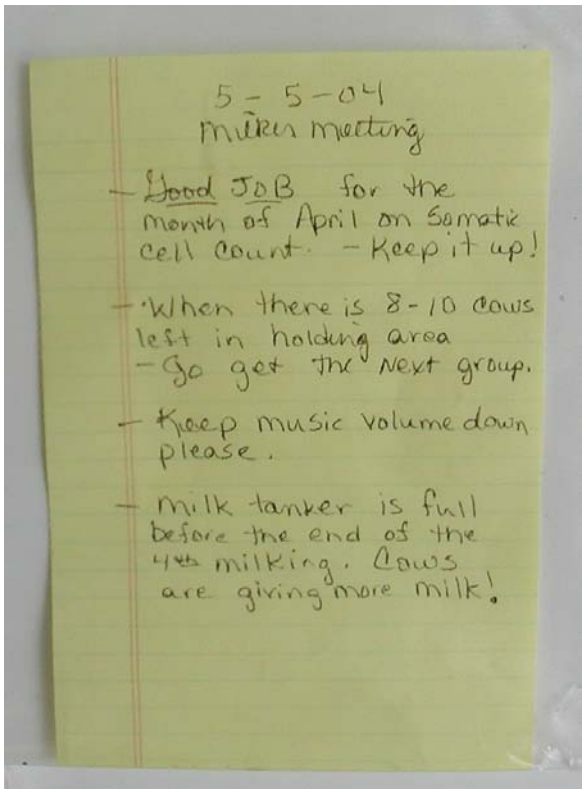
A thorough orientation on the first days of work helps an employee understand their role on the farm, how tasks are to be done, to whom they are responsible, and to whom they can go for help and answers to their questions. Even simple things like where employees should park their vehicles, where they keep their lunch and where they find tools are simple things for those experience on the farm, but are mysteries and reasons for concern for a new person coming to the farm.

At orientation, the employee should be provided with an employee manual. An employee manual may include topics such as:

- History of the farm business
- Farm mission statement
- Business policies
- Work policies
- Compensation/pay information
- Vacation policy
- Sick leave policy
- Job performance review
- Benefits
- Animal welfare expectations
- Disciplinary procedures
- Others as appropriate for the farm

A manager or another trusted employee should be assigned to the new employee for an orientation and training period. This will help acquaint the new employee with people and procedures on the farm. This time should also establish the ability for the employee to ask questions of managers when they are unsure of procedures or have concerns regarding their job.

Once you have employees in place, continued training is essential. Whether there are new tasks on the farm, of previous tasks continue on, it is important to consistently renew skills and attitudes and make sure approved procedures are reinforced on a regular basis. Even good employees tend to experience "procedural slip", where they gradually miss following accepted operating procedures. Regular training and reminders can help minimize this problem.



It's important to have as system of communicating information.

Legal Aspects of Being an Employer

If extra employees are brought onto the farm, you will need to comply with several different rules and regulations. Employees must be qualified to work in the U.S. and be able to show documentation. This goes for all employees, not just those that might be immigrants.

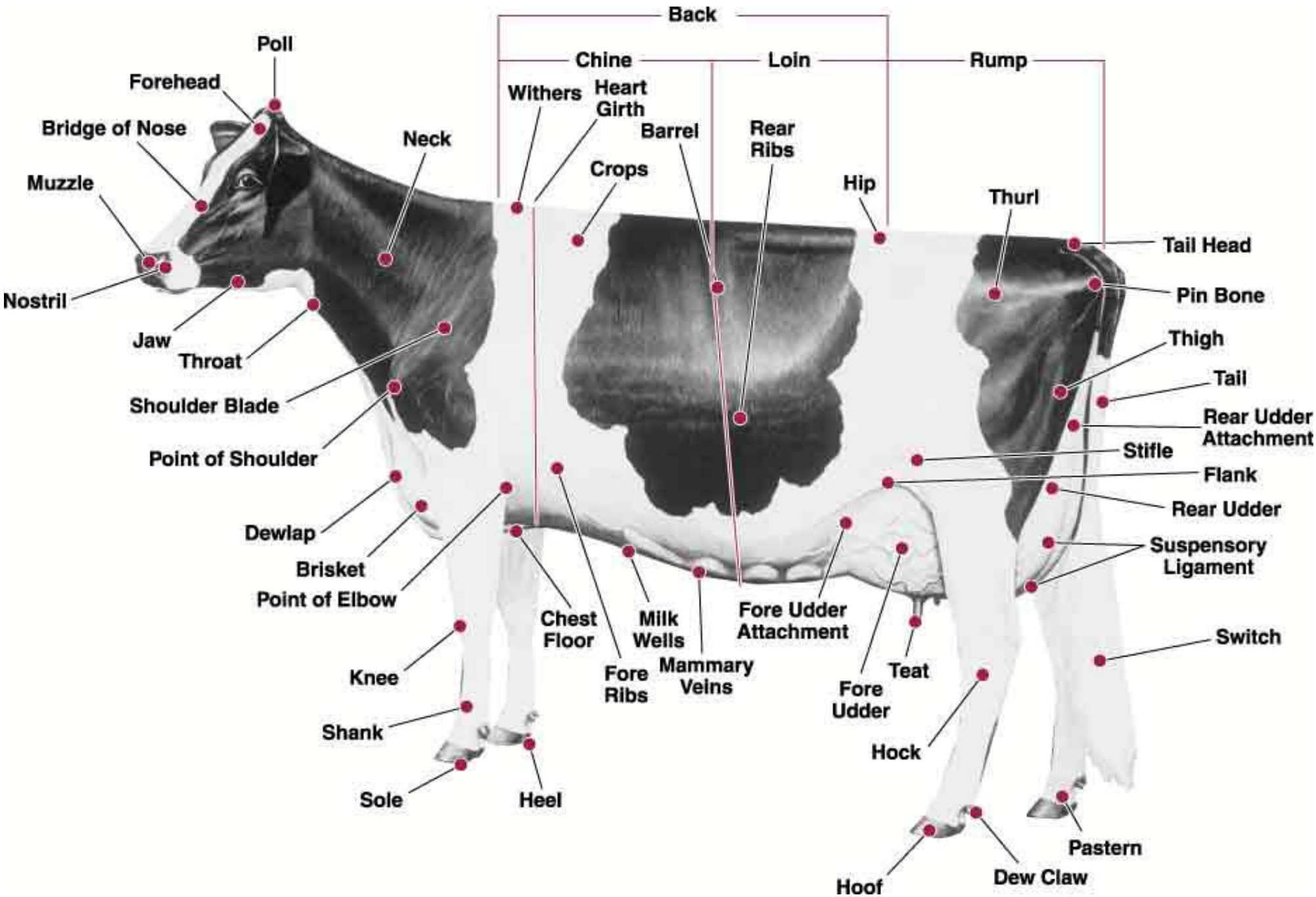
The employer is responsible for filing a variety of forms related to tax payments, social security deposits, notices of hiring with departments of human services, etc.

If a business has a large enough number of employees or hours of employment in a year, it will be subject to workers compensation and unemployment insurance. Tax forms must be filed and tax deposits made in a timely fashion. Minimum wage laws must be adhered to and proper safety and legal posters must be posted in the workplace.

Details of all these legal matters may be found in appropriate Extension publications or at state workforce and department of labor offices or websites. In Minnesota, a basic resource is the University of Minnesota Extension publication **Farm Labor Laws and Regulations**. Remember that state and federal rules change from time to time so check with appropriate agencies for current details.

Key Points:

- The right workforce can make a business more efficient and profitable
- A labor needs assessment will help determine the amount and type of labor needed on the farm.
- Assess yourself as a potential employer and if you don't feel comfortable in the role of a supervisor, identify someone who can perform that role.
- Establish and follow a carefully planned hiring plan.


Back
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Loin
Rump
Poll
Forehead
Bridge of Nose
Muzzle
Nostril
Jaw
Throat
Shoulder Blade
Point of Shoulder
Dewlap
Brisket
Point of Elbow
Knee
Shank
Sole
Heel
Neck
Withers
Heart Girth
Crops
Barrel
Rear Ribs
Hip
Thurl
Tail Head
Pin Bone
Thigh
Tail
Rear Udder Attachment
Stifle
Flank
Rear Udder
Suspensory Ligament
Switch
Pastern
Dew Claw
Hoof
Hock
Teat
Fore Udder
Fore Udder Attachment
Mammary Veins
Milk Wells
Fore Ribs
Chest Floor