



OKLAHOMA
CareerTech

Introduction to Agriscience

Unit 8
The Dairy Cattle Industry

Student Edition

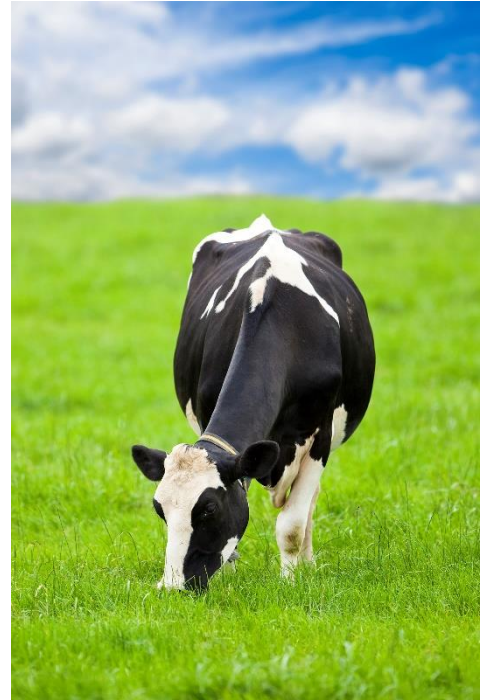
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Unit 8

The Dairy Cattle Industry

How often do you drink milk, eat yogurt or ice cream, or spread butter on your toast? If you are like most Americans, the answer is “every day!” The dairy cattle industry, the source of all of these products, is one of the most important agricultural industries. While California, Wisconsin, and New York are the states with the most dairies, Oklahoma boasts its own unique claim to dairy fame — Braum’s Dairy, one of the world’s largest. Braum’s is unusual in the dairy cattle industry because it is truly **vertically integrated**, which means that it does everything from milking the cows and growing food for the herd to manufacturing dairy products and selling the products from its own stores. The dairy cattle industry is an important part of agriculture and continues to advance in its methods of production.



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OBJECTIVES

1. Discuss the history of the dairy cattle industry and its role today.
2. Identify major breeds of dairy cattle and their characteristics.
3. Locate the parts of a dairy cow.
4. Identify consumer products derived from dairy cattle.
5. Explain the physiology of milk production.
6. Discuss recent technological advances in dairying.

KEY WORDS

alveoli
cisterns
colostrum
cream
curds
dry cow
emulsifiers
lactation

lactose
mammary system
oxytocin
pasteurization
springer
vertically integrated
whey

History of the Dairy Cattle Industry

Using the milk from other mammals as food for humans has been a practice for many thousands of years. Archeological records show that Egyptians used milk, cheese, and butter in 3,000 B.C., and milking cows is an activity recorded as early as 9,000 B.C. The history of dairying in the United States began when the first dairy cattle were brought to the Jamestown colony in 1611. For hundreds of years, dairy cattle were kept in small numbers on family farms. Milk, butter, and cheese could be processed and sold only in small quantities to local customers. Because milk and milk products are quite perishable, the lack of refrigerated transportation made large-scale dairying difficult. The mid-1800s saw the beginning of a series of inventions and processes that allowed dairying to become a thriving industry. In 1856, Gail Borden invented a process for making canned condensed milk. This allowed fluid milk to be stored for long periods. Condensed milk was a major food source during the Civil War. In 1861, mechanical refrigeration allowed milk to be transported much greater distances without spoiling.

In 1890, Stephen Babcock invented a method for determining the amount of butterfat in milk products. The Babcock Butterfat Test helped dairy farmers market and price their products according to the value of their fat content. In 1895, milk pasteurization became commercially available. **Pasteurization** is the process of heating a food product to kill bacteria. Pasteurized milk can be kept longer and is safer to drink. The first decades of the 20th century saw the introduction of homogenized milk, as well as milk fortified with vitamin D. During the 20th century, new breeding technologies had a major effect on how dairy herds were managed. Artificial insemination became commercially available in the 1930s, and embryo transfers were introduced during the 1970s.

**SAE IDEA:
Research**

**Study the effects of genetic selection
in groups of animals over time.**

In the 1990s, a hormone called recombinant bovine somatotropin (rBST), also known as recombinant bovine growth hormone (rBGH), began to be used on cows to increase milk production. The FDA ruled that milk from cows treated with this hormone is safe, but controversy over its use continues. Advances in health, production, nutrition, breeding, and technology are bringing about radical changes in the dairy cattle industry. Today, dairying involves detailed computer records kept for each cow, expensive machinery for milking, and use of the latest reproductive technologies.

Major Breeds of Dairy Cattle

Milk production is one of the most important characteristics of any dairy animal. Milk production is calculated in pounds on a yearly basis per cow, with each cow being milked an average of 305 days a year. Cows are typically milked in a dairy parlor and must have a calm disposition to keep them from becoming nervous during the milking process. Each breed of dairy cattle has its own characteristics with some known to produce more milk on average or milk with a higher fat content.

Holstein

The Holstein, also known as the Holstein-Friesian, is the most popular breed of dairy cow in the United States. This breed originated in the Netherlands. Holsteins are large with distinctive black and white or red and white markings. They are known for excellent milk production, with the average yearly production per cow at 21,167 pounds of milk. The Holstein's milk is lower in butterfat and protein than the milk of other dairy breeds.



Eileen DeBruin photo, courtesy of Oklahoma State University

Jersey

The Jersey is a British breed that originated on the Isle of Jersey. Their color varies from nearly white to mousy gray to a dark tan or fawn color. They are often darker around the head and shoulders than on the body and may have a dark tail switch. The Jersey breed is famous for butterfat and protein in the milk. They are smaller than other breeds of dairy cattle and average approximately 16,100 pounds of milk per cow.



Mark Jensen photo, courtesy of the American Jersey Cattle Association



American Guernsey Association photo

Guernsey

The Guernsey is a British breed. They are of intermediate size and are a fawn color with white markings. The Guernsey's milk is noted for its golden color, which occurs because the milk is high in beta-carotene. According to the USDA, the average yearly milk production for Guernseys is approximately 18,000 pounds.

Ayrshire

The Ayrshire breed originated in Scotland and is a particularly hardy breed. Ayrshires are moderate-sized animals that are spotted red and white in color. Ayrshire milk has a moderate amount of butterfat, but it is relatively high in protein. The average Ayrshire cow can produce about 17,230 pounds of milk.



Ayrshire Breeders' Association photo

Milking Shorthorn

This breed originated in England and is one of the oldest breeds in the world. They can be red, red and white, or roan in color. The Milking Shorthorn is not a distinct breed, but rather a segment of the Shorthorn breed. On average, Milking Shorthorns produce 15,030 pounds of milk per year.



Bruce Kuehl photo, courtesy of the American Shorthorn Society

Brown Swiss

Aptly named, this breed originated in Switzerland and is brown in color ranging from light to dark including grayish to black-brown. The breed adapts well to all types of weather and is noted for good udders, feet, and legs. Milk production is good, with the average cow's yearly production at 21,127 pounds.



Cybil Fisher photo, courtesy of The Brown Swiss Bulletin

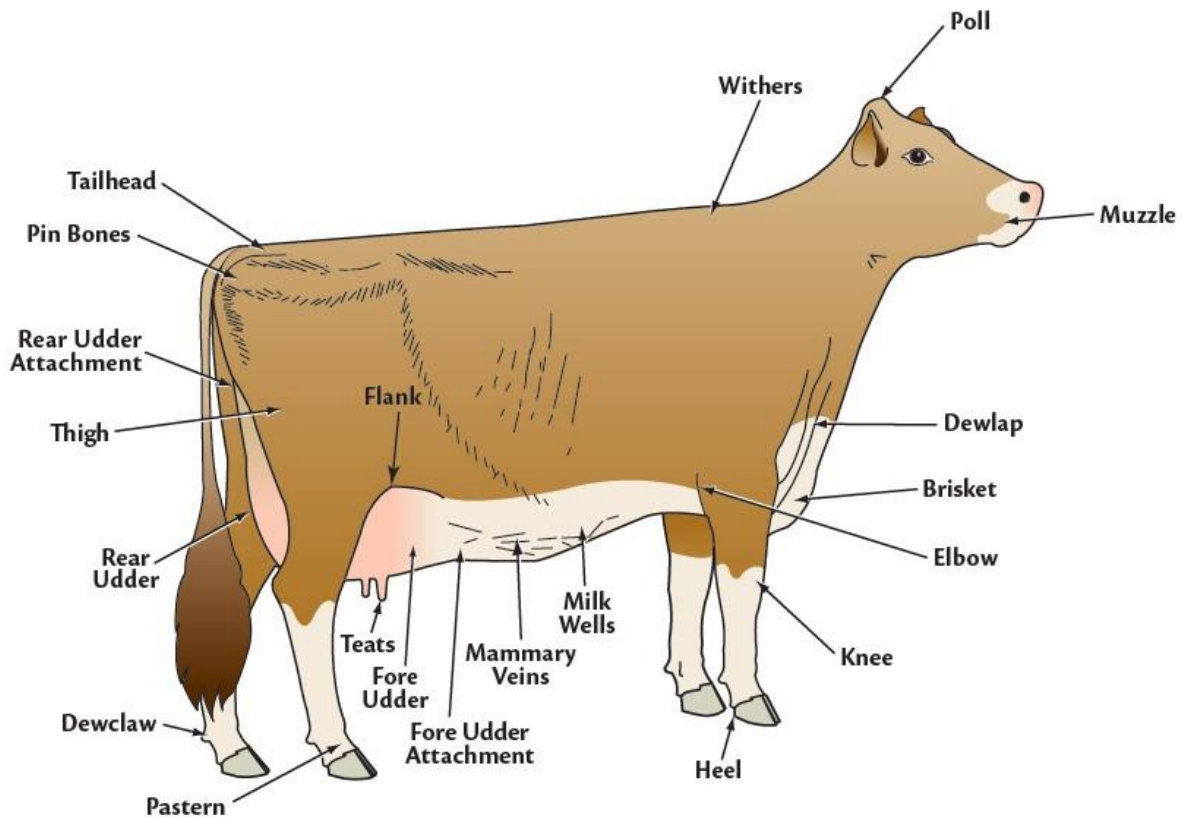
Parts of a Dairy Cow

A dairy cow has many of the same parts as a market beef animal such as the muzzle, dewlap, brisket, elbow, knee, heel, pastern, dewclaw, and tailhead. A dairy cow does have some parts not discussed on a market beef animal. The udder and teats are more apparent on a dairy cow and are of more importance due to their functionality. Also, the pin bones on a dairy cow are a prominent and significant feature. If pin bones cannot be seen on a dairy cow, the cow is storing fat instead of turning the grain and forage she eats into milk. For this reason, the visibility of the pin bones is needed.

The **mammary system**, or milk producing system, on a dairy cow is vitally important to the production of milk. On the underneath side of a cow, mammary veins should be present leading into the fore udder. These mammary veins carry blood to and from the udder. A good flow of blood to the udder helps it produce more milk. Before a cow gives birth, the blood flow increases, which stimulates milk production leading to an enlarged udder.

A cow's udder has four compartments, one for each teat, and can weigh nearly 40 pounds when empty. It is important for a cow to have strong support by ligaments to hold not only an empty udder but also an udder that is full with milk. The udder is not held by the skin, which only acts as a protective covering.

All cows are made up of these parts, but the mammary system for a dairy cow is especially important because milk production is its primary purpose. Proper placement and support of all parts is essential for maximum production.



Consumer Products

“Little Miss Muffet, sat on a tuffet, eating her curds and whey.” This common nursery rhyme tells of two milk production products. When milk is curdled and strained, the watery portion left is the **whey**. In the rhyme, Little Miss Muffet was eating cottage cheese because the **curds**, or solid portion, were left with a slight bit of the whey left in the mixture.

**SAE IDEA:
Exploratory**
Visit a milk processing plant or a cheese factory to examine how cheese is made or how milk is processed.

The dairy cattle industry provides consumers with a wide range of products. Most of these are derived from milk, though veal and beef are also products of the industry. There are so

many different products made from milk that it is easiest to consider them in categories: fluid milk, creams, concentrated milks, cultured milk, frozen products, cheeses, and butter.

Fluid Milk Products

Most fluid milk products can be separated into whole milk, reduced-fat, low-fat and fat-free types. Whole milk has not had the fat content reduced. It has no less than 3.25 percent milk fat and contains 8 grams of fat per eight-ounce serving. It is pasteurized, homogenized, and fortified with Vitamin D.

Reduced-fat, low-fat, and fat-free milk have had some or all of the fat removed from them. Reduced-fat milk is 2 percent fat; low-fat milk is 1 percent fat; and fat-free milk has no fat (also called skim milk). These products are normally pasteurized, homogenized, and fortified with Vitamins A and D.

Raw milk is whole milk that has not been homogenized, pasteurized, or fortified. This is milk in the same form that it comes out of the cow, so it contains some types of bacteria and proteins that are normally destroyed in the pasteurization process. Because it is not homogenized, the milk will separate and the cream will rise to the top. Raw milk must be labeled as such, since state and federal food safety laws generally require that milk be pasteurized. Dairies that produce raw milk for



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sale must undergo very strict health and safety inspections of the cows, the dairy, the employees, the machinery, and the milk itself to ensure that it is safe for people to drink.

SAE IDEA:
Entrepreneurship
Make products such as butter to sell at a local farmer's market.

Flavored milks are popular with kids and adults. Chocolate milk is the most common, though you will also find flavors such as vanilla, strawberry, and mocha on the grocery store shelf. Flavored milks are usually made with reduced-fat or low-fat milk and have had flavorings and stabilizing agents added.

Lactose-reduced and lactose-free milk is available for people who are lactose intolerant. **Lactose** is a naturally occurring sugar in milk. Lactose intolerance means that a person's digestive system does not have the enzymes needed to break down the sugar. Drinking milk can make these people feel ill. Lactose-reduced and lactose-free milks are a good alternative for such individuals.

Creams

Cream is the portion of the milk that rises to the top. It consists of about 40 percent milk fat in its normal state. Cream is combined with varying amounts of milk and other ingredients, such as emulsifiers and stabilizers, so that different types of cream products can be made. Cream is normally pasteurized or ultra-pasteurized.

TYPES OF CREAM

Half-and-half — blend of milk and cream and contains between 10.5 and 18 percent milk fat

Light cream — 18 to 30 percent milk fat, "table cream" or "coffee cream"

Light whipping cream — 30 to 36 percent milk fat

Heavy whipping cream — at least 36 percent milk fat, whips more readily than light whipping cream



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Concentrated and Dry Milks

Evaporated milk is pasteurized milk that has had 60 percent of the water removed from it. It is then homogenized, usually fortified, and canned. This product is often used for cooking. Sweetened condensed milk is another canned milk product often used in recipes. As with evaporated milk, about 60 percent of the water is removed from pasteurized milk that has been sweetened with sugar. The sweetener also prevents spoilage.

Dry milk comes in non-fat and whole forms. This milk is in powdered form and can be used for cooking, or it can have water added to reconstitute as fluid milk. Dry buttermilk is also available. Malted milk makes a tasty beverage. It is made from milk that has malt added before the mixture is dehydrated into powdered form.

THE STORY OF MALTED MILK — A REAL “WHOPPER”

Did you know that malted milk—the all-American treat—was originally sold as a health food? Malted milk was first invented in the 1870s by brothers James and William Horlick of Racine, Wisconsin. Their process for making malted milk involved mashing malted barley and wheat flour, mixing in whole milk, and then evaporating the milk to a dry form under a vacuum. The product was originally marketed as a nutritious drink mix for infants and invalids. Also, for reasons then not fully understood, it was recognized that malted drinks helped people to fall asleep. Because of this, the product was also promoted as “a cure for night starvation.”

The Horlicks’ product was sold in powdered and tablet form. In addition, it was featured at drugstore soda fountains as an ingredient in chocolate milkshakes, which later became known as “malted” or simply “malts.”

The malt in a malted milkshake makes the drink very different from a regular milkshake. Malt is made from grain which is allowed to soak and sprout before being lightly toasted. Sprouting converts most of the grain’s sugar into starch. Toasting then caramelizes the sugars and gives the malt a nutty, sweet taste. As you may have guessed, because of the sugars, malt is high in calories.

The Horlick Company was eventually sold and moved to England, and the Racine plant closed in 1975. Horlick malt tablets and powdered drink mixes are now hard to find in the United States, though they can often be ordered through specialty food stores. But malted milk can still be found in many other food items such as the candy favorite “Whoppers.”

Cultured Dairy Foods

Yogurt is a very popular cultured product. It is made with a mixture of milk and cream fermented by an active culture of lactic acid-producing bacteria. It can be found plain or with a variety of fruit flavorings and sweeteners.

Acidophilus cultured milk has the active culture *Lactobacillus acidophilus* added to it. This bacterium is considered an aid to digestion. Acidophilus milk is also normally pasteurized and homogenized. Sour cream is cream that has been treated with lactic acid-producing bacteria to produce a thickened product with a characteristic tangy taste.



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Buttermilk was once a by-product of making butter but is now generally made through culturing milk with appropriate types of bacteria. It can be made with whole, reduced-fat, or non-fat milk.

Frozen Dairy Foods

Ice cream is a mixture of milk, cream, sweeteners, and flavorings that is stirred together as it is frozen. Commercial ice cream usually includes other ingredients such as stabilizers and emulsifiers.

Emulsifiers are substances that keep together liquids that tend to separate such as oil and water. Ice cream has a minimum of 10 percent milk fat. Ice milk is similar to ice cream, but it contains less milk fat at 3 to 5 percent.

Sherbet contains less milk fat and more sugar than ice cream. It is usually made with a mix of syrup or fruit juice and contains between 1 and 2 percent milk fat. Frozen yogurt is a mixture of pasteurized milk, lactic acid cultures, and other ingredients that is stirred and frozen to make either a hard or soft, frozen product. Frozen yogurt that is pasteurized before it is frozen will not contain the live active cultures that are part of what some claim makes yogurt a healthful food. Some manufacturers add these live cultures after pasteurization.

Cheese

SAE IDEA: Placement

Work for a local dairy farmer.

According to the National Dairy Council, about one-third of all the milk produced in the United States is used to make cheese. Natural cheeses are made from milk protein called *casein*. There are more than 400 varieties of natural cheese that are classified according to their degree of hardness.

Processed cheeses are made using natural cheeses blended with other ingredients, such as emulsifiers, to produce a moister product with a more uniform texture. Pasteurized processed cheeses are blends of natural cheeses that have been processed using heat. Cold pack is a blend of natural cheeses that are processed without using heat. Special flavorings are often added. Cheese spreads are flavored, spreadable cheeses such as garlic-flavored or pimento cheese spread.



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CHEESE CLASSIFICATION

Hard cheeses: Parmesan, Swiss, Romano, Cheddar, Gruyere, and Colby

Firm cheeses: Edam, Gouda, and Provolone

Semi-soft cheeses: Bleu, Mozzarella, and Limburger

Soft cheeses: Brie, Camembert, Feta, Ricotta, Cottage Cheese, and Cream Cheese

Butter

Butter is made from pasteurized cream and is 80 percent milk fat. Lightly salted butter has salt added, which modifies the flavor and acts as a preservative. Unsalted butter has not had salt added to it – many cooks prefer to use unsalted butter in recipes. Whipped butter has air mixed in to increase its volume, making it softer and more spreadable.

Milk Production

Like all other mammals, a cow produces milk to nourish her young. She will not produce any milk unless she has a calf. Dairy heifers begin their milking life by being bred at about 15 months of age, and since the gestation period is nine months, a heifer will give birth around two years of age. A cow is rebred about three months into her **lactation**, or milking period to complete a yearly cycle of calving, lactation, drying off, and calving again. After a cow has been bred and begins to show signs of pregnancy, she is called a **springer**.

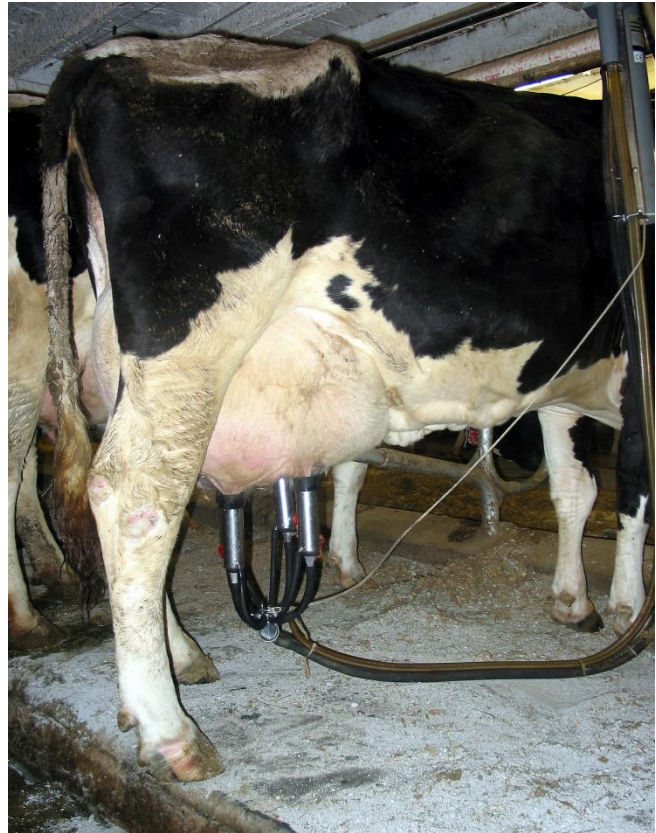
About two months before calving, a cow will begin to dry up or stop producing milk in preparation for birth. During this time, she is deemed a **dry cow**. This period is important to ensure cows restore nutrients and health in preparation for the next lactation period. The first milk a cow produces after calving is called **colostrum**, which contains nutrients vital to the health of the newly born calf.



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The cow's udder has four quarters, each with its own mammary gland. Within the mammary gland are groups of tiny units called **alveoli**, where the milk is produced. The alveoli are connected with a system of ducts to larger holding areas called **cisterns**. Each quarter of the udder has a gland cistern, which holds about two pounds of milk. Each gland cistern drains into its own teat cistern, which is connected to the outside of the teat by the streak canal. On average, one cow can produce 6-8 gallons of milk each day.

To get milk from the cow, she must be stimulated to have a milk letdown reflex. In the natural state, a calf sucking on the teat would cause this reflex to happen. At a dairy, the procedures associated with being milked serve the same purpose. When the cow experiences this type of activity, she produces a hormone called **oxytocin** that starts the milk letdown reflex. After milking, the process of manufacturing and storing milk begins again.



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Technological Advances

The dairy cattle industry has been at the forefront of many of the technologies in use with livestock today. Dairy farmers continue to boost production and efficiency through expanding knowledge and new technologies. Just a few examples are found with reproductive technology, electronic animal identification, and robotic milking.

Embryo Transfer

A dairy farmer's success largely depends on the productivity of the cows. A high-producing cow is an asset and one from which the farmer will want to raise many replacement heifers. In the past, this process was slow, since even the best cow can only bear one calf per year. However, the ability to transfer an embryo from one cow to another is a relatively new technology that allows cows to produce several calves in a year. Like artificial insemination, which allows a bull to sire far more offspring than would be possible from natural service, embryo transfer allows a cow to pass her traits to numerous offspring each year.

Embryo transfer is performed by removing fertilized eggs from the superior cow and transplanting them into surrogate cows. The embryo grows and is born to the surrogate mother, but the calf is a genetic offspring of the donor. One problem associated with embryo transfer is that any potential genetic problems the cow has are transferred to more calves than would normally be possible. Along with the transfer of embryos, it is possible to test semen and embryos for gender, which would allow producers to add offspring of a particular gender to their herds.

Electronic Identification

Electronic identification is used with all kinds of animals, including pets and livestock. In the dairy cattle industry, electronic identification can be attached as an ear tag, a tag on a neck chain, as an injectable microchip, or as a rumen bolus that the animal swallows. An electronic reader gathers the coded information from the transponder in the animal.



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Information encoded on the electronic dairy tag could include the breed, date of birth, the animal's location, and health and performance data. At a dairy farm, this information can be used to identify the animal when it enters the milking parlor. Such systems may even provide cows with individual feed rations. Data from the electronic identification system and the milking system are recorded in a database to make a complete production record for the cow.

Robotic Milking

Because milking a herd of dairy cows is extremely labor-intensive, automating this chore with a robotic milking system could save a great deal of work and expense. Robotic milking systems are far from common, though they can be found more frequently in Europe than in the United States. Robotic milking requires cows to be trained to use it. Cows enter a milking stall voluntarily.

Once in the stall, the system recognizes and records the cow's identity electronically. It then provides feed for the cow and begins the robotic milking process. The robot cleans the cow's udder and attaches the milking machine to her udder just as a human worker would do. The milking machine automatically detaches when the cow has finished producing milk and the cow is allowed to exit the milking stall. Robotic milking allows producers to milk hundreds of cows in one day and is part of some of the largest dairy operations in the world.



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UNIT SUMMARY

The dairy cattle industry provides consumers with a variety of products but not without the hard work of thousands of dairy farms across the nation. Each of these dairy farms houses different breeds of dairy cattle each for different reasons such as milk yields or milk fat content. Of all the parts on a dairy cow, the mammary system is the most important. The functionality of this system is what allows a cow to produce milk after each calf is born, with each cow averaging 6-8 gallons of milk each day. Milk production is a complex process controlled by natural hormones. Through technological advances, consumers have products such as fluid milk, cheese, ice cream, and butter to name a few. As technology continues to increase, dairy production will also continue to become more efficient, resulting in a better product for consumers.

UNIT REVIEW

1. Explain the term vertically integrated.
2. What made large-scale dairy farming difficult before the 1800s?
3. How has pasteurization changed the dairy cattle industry?
4. How many days on average are cows milked?
5. Which breed of dairy cattle is the most popular in the United States?
6. Which breed produces milk high in beta-carotene?
7. Which breed is a segment of another breed of cattle?
8. Why is it important that pin bones be visible on a dairy cow?
9. Name the four classes of treated fluid milk and explain the differences.
10. How is evaporated milk made?
11. Name two examples of cultured dairy foods.
12. What must a cow or heifer do before she is able to produce milk?
13. Explain embryo transfer.
14. What is robotic milking?

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