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2026 Virginia 4-H Dairy Quiz Bowl Study Materials

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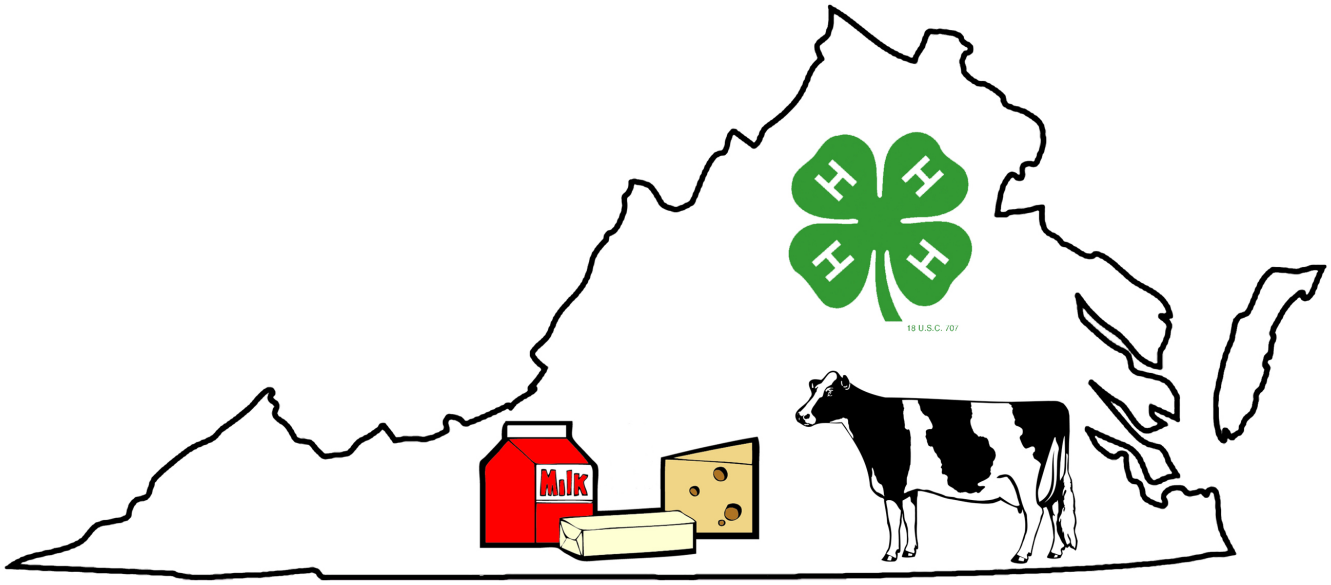

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Note

Senior 4-H members competing in 4-H dairy quiz bowl contests in Virginia may be quizzed on any of the information contained within this year's study materials.

Junior 4-H members will only be responsible for those marked with an asterisk (Chapters 1-11).

Disclaimer

This publication is a living document and is updated on an annual basis. Given the pace of change in today's world, information can become dated very quickly. If you find information that has changed, feel free to contact the author, so your suggestions may be included in the next revision. Thank you!

Chapter 1: Dates in Dairy History

1611 – First cows arrived at the Jamestown Colony

1624 – First cows arrived at the Plymouth Colony

1810 – First dairy cooperative in the U.S. organized in Goshen, Connecticut

1851 – First commercial cheese factory established in New York

1856 – First patent for condensed milk | First commercial butter factory established in New York

1857 – First successful condensery built by Gail Borden in Burrville, Connecticut

1862 – Morrill Act enacted (created the Land Grant College System)

1868 – American Jersey Cattle Club founded

1877 – American Guernsey Cattle Club founded

1878 – Centrifugal cream separator invented by Dr. Gustaf de Laval

1880 – Brown Swiss Breeders Association founded

1884 – Milk bottle invented by Dr. Harvey Thatcher in Potsdam, NY

1885 – *Hoard's Dairyman* magazine first published; Holstein-Friesian Association of America formed

1886 – Automatic bottle filler and capper patented

1887 – Hatch Act enacted (created state agricultural experiment stations)

1890 – Babcock test for butterfat developed

1895 – Pulsator invented

1904 – American Dairy Goat Association organized

1905 – First cow testing association in the U.S. organized in Michigan

1906 – American Dairy Science Association founded | First National Dairy Show held in Chicago | Brown Swiss cattle recognized as an official dairy breed in the U.S.

1906 – National Dairy Council organized

1914 – Smith-Lever Act signed (established the Cooperative Extension Service)

1916 – National Milk Producers Federation founded

1917 – Journal of Dairy Science first published

1922 – Capper-Volstead Act passed (empowered farmers and agricultural producers to market, price, and sell their products through cooperative means)

1927 – Cow Testing Association renamed Dairy Herd Improvement Association (DHIA)

1931 – *Hoard's Dairyman* cow judging contest begun

1932 – First plastic-coated paper milk cartons introduced commercially

1935 – National Cooperative Sire Proving Program initiated

1936 – First dairy cattle A.I. organization in Denmark

1937 – First list of sires proven in DHIA testing published by USDA | Federal Agricultural Marketing Agreement Act passed establishing Federal Milk Marketing Orders

1938 – Artificial insemination began in the U.S. | First A.I. cooperative in the U.S. organized in New Jersey by E. J. Perry | First bulk tanks used on farms

1940 – American Dairy Association founded | Purebred Dairy Cattle Association formed

1942 – National Association of Animal Breeders organized

1943 – PDCA Dairy Cow Unified Scorecard was first copyrighted

1945 – First edition of National Research Council's Nutrient Requirements of Dairy Cattle published

1949 – National Dairy Shrine founded

1951 – Computer first used to calculate DHIA records in Utah | First U.S. young sire sampling program established | First successful embryo transfer in dairy cattle | First commercial milk replacer for calves introduced

1953 – Frosty, the first U.S. calf resulting from frozen semen, was born

1955 – Flavor control equipment introduced commercially

1960 – National Mastitis Council founded

1964 – Commercial introduction of plastic milk jug | Red and White Dairy Cattle Association organized

1965 – National Dairy Herd Information Association organized

1967 – World Dairy Expo founded and held first show

1974 – Nutrition labeling of fluid milk products begins

1983 – INTERBULL developed; Dairy and Tobacco Adjustment Act passed (created National Dairy Promotion and Research Board and a 15-cent dairy check-off)

1988 – Multiple component pricing was first used by a Federal Milk Marketing Order

1989 – Animal Model first used for USDA genetic evaluations

1993 – Bovine somatotropin, first product of biotechnology for animals, approved

1994 – Holstein-Friesian Association officially changes its name to Holstein Association USA, Inc.

1995 – Multi-trait Across Country Evaluations (MACE) for bulls implemented by INTERBULL

1998 – Dairy Calf and Heifer Association founded

2000 – First U.S. commercial robotic milker installed in Wisconsin

2002 – North American Intercollegiate Dairy Challenge established

2003 – Sexed semen becomes commercially available

2006 – Dairy Cattle Reproductive Council founded

2009 – Genomic predictions of genetic merit officially released by USDA-AIPL | Jersey Youth Academy established

2013 – Council on Dairy Cattle Breeding assumes responsibility for publishing U.S. dairy genetic evaluations

2021 – Eighth revised edition of the Nutrient Requirements of Dairy Cattle published

2023 – Dairy Calf and Heifer Association published 4th edition of DCHA’s Gold Standards

2024 – FARM Animal Care Version 5 implemented

2025 - PDCA Dairy Cow Unified Scorecard, PDCA Showmanship Evaluation Card, and PDCA Show Ring Code of Ethics most recently revised | Federal Milk Marketing Order reform took effect with updated class price calculations

Chapter 2: Agencies, Organizations, and Leaders

Abbreviations

AABP – American Association of Bovine Practitioners

ADA – American Dairy Association

ADGA – American Dairy Goat Association

ADSA – American Dairy Science Association

AFBF – American Farm Bureau Federation

AJCA – American Jersey Cattle Association

AMS – Agricultural Marketing Service

AVMA – American Veterinary Medical Association

AOAC – American Organization of Analytical Chemists

APHIS – Animal and Plant Health Inspection Service

ARS – Agricultural Research Service

CCC – Commodity Credit Corporation

CME – Chicago Mercantile Exchange

CSS – Certified Semen Services

DCHA – Dairy Calf and Heifer Association

DCRC – Dairy Cattle Reproduction Council

DHIA – Dairy Herd Information Association

DHIR – Dairy Herd Information Registry

DRPC – Dairy Records Processing Center

EPA – Environmental Protection Agency

FAS – Foreign Agricultural Service

FASS – Federation of Animal Science Societies

FCS – Farm Credit Services

FDA – Food and Drug Administration

FSA – Farm Service Agency

FSIS – Food Safety and Inspection Service

IDF – International Dairy Federation

IDFA – International Dairy Foods Association

NAAB – National Association of Animal Breeders

NADC – National Animal Disease Center

NAIDC – North American Intercollegiate Dairy Challenge

NASEM – National Academies of Sciences, Engineering, and Medicine

NASS – National Agricultural Statistics Service

NCIMS – National Conference on Interstate Milk Shipments

NDC – National Dairy Council

NDHIA – National Dairy Herd Information Association

NDPRB – National Dairy Promotion and Research Board

NIFA – National Institute of Food and Agriculture

NMC – National Mastitis Council

NMPF – National Milk Producers Federation

NRCS – Natural Resource Conservation Service

PDCA – Purebred Dairy Cattle Association

SWCD – Soil and Water Conservation District

UDIA – United Dairy Industry Association

USDA – United States Department of Agriculture

USDEC – United States Dairy Export Council

YDLI – Young Dairy Leaders Institute

Dairy Industry Pioneers

S. M. Babcock developed the butterfat test that was the basis for DHIA testing.

Gail Borden received the first patent for condensed milk.

Dr. Gustaf de Laval invented the centrifugal cream separator.

W. D. Hoard founded *Hoard's Dairyman*, the national dairy farm magazine.

Louis Pasteur invented pasteurization: considered the first person to discover that bacteria cause food spoilage and disease.

Dr. Harvey Thatcher invented the milk bottle.

Dairy Industry Leaders

Gregg Doud – President and CEO of the National Milk Producers Federation

Jay Mattison – CEO of National DHIA

Jerry Bowman – Executive Director of the American Dairy Science Association

Kylene Anderson – Managing Editor of *Hoard's Dairyman*

Karen Lee – Managing Editor of Progressive Dairy

Mike Opperman – Executive Director of National Dairy Shrine

Laura Herschleb – General Manager, World Dairy Expo

Barbara O'Brien – President and CEO of Dairy Management, Inc.; President and CEO of Innovation Center for U.S. Dairy

Krysta Harden – President and CEO of the U.S. Dairy Export Council

Molly Kelley – Executive Director of the North American Intercollegiate Dairy Challenge

Patti Smith – CEO and President of the American Dairy Products Institute

Michael Dykes – President and CEO of the International Dairy Foods Association

David West – Executive Director of the American Butter Institute

Agricultural Leaders in Government

Brooke Rollins – U.S. Secretary of Agriculture

Sen. John Boozman (R-AR) – Chair, U.S. Senate Agriculture, Nutrition, & Forestry Committee

Rep. Glenn Thompson (R-PA) – Chair, U.S. House Committee on Agriculture

Breed Association Leaders

Amy Fletcher – Operations Manager, U.S. Ayrshire Breeders Association

Alicia Horn – Executive Secretary, Brown Swiss Cattle Breeders Association

Robin Alden – Executive Secretary, American Guernsey Association

Lindsey Worden – CEO/Executive Secretary, Holstein Association USA, Inc

Neal Smith – Executive Secretary and CEO, American Jersey Cattle Association

Kate Gulley – Executive Secretary, American Milking Shorthorn Society

Nicholas Randle – President, Red & White Dairy Cattle Association

Dairy Related Organizations

The Holstein Foundation's education, leadership development, and outreach programs serve youth and young adults representing all breeds of dairy cattle.

The Council on Dairy Cattle Breeding oversees approval of records systems standards. The council appoints the group to certify performance of DHIs and other herd record providers.

The four Dairy Records Processing Centers (DRPCs) in the U.S. are:

- AgriTech Analytics
- AgSource
- Amelicor
- Dairy Records Management Systems

The National Dairy Shrine Museum is in Fort Atkinson, Wisconsin.

The American Dairy Science Association (ADSA) is an international organization of educators, scientists, and industry representatives who are committed to advancing the dairy industry.

- The *Journal of Dairy Science* is the organization's official scientific publication.
- ADSA has two divisions in its organizational structure – Production and Dairy Foods.

Organization Headquarters

American Butter Institute – Arlington, VA

American Dairy Products Institute – Elmhurst, IL

American Dairy Science Association – Champaign, IL

Council on Dairy Cattle Breeding – Bowie, MD

Dairy Calf and Heifer Association – New Prague, MN

Dairy Cattle Reproduction Council – New Prague, MN

Dairy Cattle Welfare Council – Champaign, IL

Hoard's Dairyman – Fort Atkinson, WI

International Dairy Foods Association – Washington, DC

Milk and Dairy Beef Quality Assurance Center – Stratford, IA

National Dairy Shrine – Fort Atkinson, WI

National DHIA – Fitchburg, WI

National Milk Producers Federation – Arlington, VA

Event Locations

All-American Dairy Show – Harrisburg, PA

Eastern States Exposition (The Big E) – West Springfield, MA

National 4-H Dairy Conference – Madison, WI

North American International Livestock Exposition – Louisville, KY

World Dairy Expo – Madison, WI

Chapter 3: Dairy Breeds

The seven major breeds recognized by the Purebred Dairy Cattle Association are:

- Ayrshire
- Brown Swiss
- Guernsey
- Holstein
- Jersey
- Milking Shorthorn
- Red & White

Ayrshire

Place of origin – County of Ayr, Scotland

Arrived in the United States – 1822

Mature bodyweight – 1,300 lb.

Permanent ID method – Official tattoo or American ID tag

Association name – U.S. Ayrshire Breeders Association

Association headquarters – Brattleboro, Vermont

Breed magazine – The Ayrshire Digest

Holstein Association USA provides managed services for the U.S. Ayrshire Breeders Association.

Brown Swiss

Place of origin – Switzerland

Arrived in the United States – 1869

Mature bodyweight – 1,500 lb.

Permanent ID method – Ear tattoo or official AIN eartag

Association name – Brown Swiss Cattle Breeders' Association

Association headquarters – Beloit, Wisconsin

Breed magazine– Brown Swiss Bulletin

Brown Swiss cattle were originally used for milk, meat, and draft purposes.

Today's Brown Swiss cattle are known for high protein to fat ratio, longevity, sound feet and legs, and having few health problems.

Guernsey

Place of origin – Isle of Guernsey

Arrived in the United States – 1840

Mature bodyweight – 1,400 lb.

Permanent ID method – RFID tag, photo, sketch, or ear tattoo

Association name – American Guernsey Association

Association headquarters – Columbus, Ohio

Breed magazine – Guernsey Breeders Journal

Guernsey milk is known for its golden color.

Holstein

Place of origin – Netherlands and Germany

Arrived in the United States – 1852

Mature bodyweight – 1,600 lb.

Permanent ID method – Eartag ID, photo, or sketch

Association name – Holstein Association USA, Inc.

Association headquarters – Brattleboro, Vermont

Breed magazine – *The Pulse*

Holsteins make up about 90% of the U.S. dairy cow population.

The three colors found in registered Holstein cattle are black, red, and white.

On average, Holsteins produce more milk per cow than the other dairy cattle breeds.

Jersey

Place of origin – Isle of Jersey

Arrived in the United States – 1850s

Mature bodyweight – 1,100 lb.

Permanent ID method – Approved eartag or legible tattoo

Association name – American Jersey Cattle Association

Association headquarters – Reynoldsburg, Ohio

Breed magazine – *Jersey Journal*

Jerseys generally produce milk with the highest fat and protein content.

Milking Shorthorn

Place of origin – England

Arrived in the United States – 1783

Mature bodyweight – 1,400 lb.

Permanent ID method – Ear tattoo, RFID tag, laser printed tag, or button tag

Association name – American Milking Shorthorn Society

Association headquarters – Beloit, Wisconsin

Breed magazine – Milking Shorthorn Journal

Red & White

Mature bodyweight – 1,500 lb.

Association name – Red and White Dairy Cattle Association

Association headquarters – Watertown, Wisconsin

Breed magazine – The Red Bloodlines

The Red and White Dairy Cattle Association has an open herdbook with different levels of registry. The organization allows different breeds in their herdbook, not just red and white Holsteins.

Notable Animals

Brown Swiss milk production leader – Lost Elm Prelude Pixy ET (65,430 lb.)

Holstein milk production leader – Selz-Pralle Aftershock 3918 (78,170 lb.)

Jersey milk production leader – Mainstream Barkly Jubilee (55,590 lb.)

World lifetime milk production record holder – Gillette E Smurf

Queen Mother of the Brown Swiss breed – Jane of Vernon

First bull to produce one million units of semen – Fisher-Place Mandingo-TW

2025 Supreme Champion of World Dairy Expo – Golden-Oaks Temptres-Red-ET (Red & White)

Chapter 4: Dairy Cattle Judging, Fitting, and Showing

Anatomy Related to Judging

The hock is used as the reference point to determine the height of the udder floor.

The parts of a cow's anatomy that may be twisted to one side and called "wry" are the face and tail.

The main udder supports are the median suspensory ligament, lateral suspensory ligament, and skin.

The median suspensory ligament is the major support of the udder and divides it in half when viewed from the rear.

The subcutaneous abdominal veins are also called the milk veins.

Judging Scorecards

Table 1. PDCA Dairy Cow Unified Scorecard

Category	Points	Traits in Priority Order
Frame	15	Rump, front end, back/loin, stature, breed characteristics
Dairy Strength	25	Ribs, chest, barrel, thighs, neck, withers, skin
Feet and Legs	20	Movement, rear legs - side view, rear legs - rear view, feet, thurl position, hocks, bone, pasterns
Udder	40	Udder depth, rear udder, teat placement, udder cleft, fore udder, teats, udder balance and texture

Table 2. Dairy Heifer Scorecard (Unofficial)

Category	Points
Frame	40
Dairy Strength	20
Feet and Legs	30
Body Capacity	10

Judging Contests

The *Hoard's Dairyman* Cow Judging Contest consists of 5 picture classes. The contest begins with the January 10 issue each year.

The National 4-H Dairy Cattle Judging Contest and the National Intercollegiate Dairy Cattle Judging Contest are held at the World Dairy Expo in Madison, Wisconsin.

There are four animals in a class in a 4-H dairy judging contest.

The All-American Invitational Youth Dairy Cattle Judging Contest is held at the All-American Dairy Show in Harrisburg, Pennsylvania.

The (NAILE) Invitational Youth Dairy Judging Contest is held at the North American International Livestock Exposition in Louisville, Kentucky.

Heifer Classes

The individual heifer classes in a dairy show are:

- Summer heifer calf
- Spring heifer calf
- Winter heifer calf
- Fall heifer calf
- Summer yearling heifer
- Spring yearling heifer
- Winter yearling heifer
- Fall yearling heifer

Showmanship

When exhibiting a dairy animal, the parading circle before the judge should move clockwise.

One should lead a dairy animal from the left side of the animal.

PDCA Showmanship Evaluation Card

Slight Discriminations

Exhibitor

- Inappropriate halter (beef, nylon, rope)
- Lead strap tightly looped
- Failure to enter the ring walking forward at a smooth, efficient pace
- Has stiff outstretched arm
- Has poor posture – either overly stiff or slumped, sloppy
- Improper head carriage, animal's nose is too high
- Calf's head is not turned slightly toward judge when hide is felt
- Stepping on or kicking at the animal's front feet. (Note that a slight touch to move animal's front feet is allowed and should not be discriminated against)
- Inappropriate size of calf for competitor

Animal

- Minor instances of animal not handled well
- Is not alert
- Muzzle is not wiped clean
- Switch is not brushed and fluffed
- Clipping lines not properly blended

Moderate Discriminations

Exhibitor

- Not wearing white clothing or show-approved professional attire
- Inappropriate or unprofessional attire that draws attention to the exhibitor
- Wearing clothing with farm or commercial advertising/logos
- Does not know birth date, fresh date, breeding date, due date
- Unable to recognize type faults of the animal*
- Halter not fitting or put together properly
- Holding the halter in the right hand
- Holding the lead strap too far from the halter
- Has fingers in ring of the halter
- Failure to hold throat when needed
- Improper head carriage, animal's head held too low
- Unable to show animal to best advantage
- Slow response to judge or ring official
- Inattentiveness
- Watching the judge too intently
- Over-showing
- Leading too slowly
- Has elbow or hands up
- Is too far to outside or inside of ring
- Incorrect spacing to the animal in front when on parade
- Sidesteps when leading calf
- Doesn't turn and walk forward quickly into line
- Failure to stop and set up your animal appropriately at the judge's request. (Heifers: place rear leg nearest the judge back, Cows: place rear leg nearest the judge forward)
- Front legs not squarely positioned
- Does not keep animal straight from head to tail in lineup
- Crowding or bumping other animals when pulled in line
- Leaving extra space in line
- Failure to maintain a straight lineup
- Moves excessively in line
- Unable to back up animal
- Chewing gum

Animal

- Legs not clipped
- Dirt/dust in hair coat
- Dirt/wax in ears
- Feet not cleaned
- Excessive use of hair sprays, powder and other fitting products
- Clipping too early; hair appears too long
- Incomplete clipping
- Excessive clipping

Severe Discriminations

Exhibitor

- Lead strap looped & fastened
- Striking the animal
- Positioning animal's rear legs by stepping on rear feet
- Fusses with or moves calf to the extreme
- Minor instances of unsportsmanlike conduct
- Is late to class
- Wearing inappropriate shoes
- Chewing tobacco
- Carries or talks on a cell phone

Animal

- Animal causing disturbances to others

Disqualifications

- Violations of PDCA Show Ring Code of Ethics
- Unsportsmanlike conduct
- Repeated striking of the animal

Recommendation for Evaluation of the Topline

Topline:

- Is groomed
- Does not distract from the animal's overall appearance
- Conforms to the guidelines of the PDCA Show Ring Code of Ethics

Show Ethics

A dairy animal can be disqualified from being shown in the show ring for the following reasons:

- Blind quarter
- Permanent lameness
- Total blindness
- Freemartin heifer
- Tampering to conceal faults

Ohio was the first state to make tampering with show cows a crime.

Final Classification Scores

Table 3. Brown Swiss Final Classification Scores

Classification	Score
Excellent	90-95
Very Good	85-89
Good Plus	80-84
Good	75-79
Fair	65-74
Poor	60-64

Table 4. Holstein Final Classification Scores

Classification	Score
Excellent	90-97
Very Good	85-89
Good Plus	80-84
Good	75-79
Fair	65-74
Poor	50-64

Table 5. Jersey Final Classification Scores

Classification	Score
Excellent	90 +
Very Good	80-89
Desirable	70-79
Acceptable	60-69
Poor	50-59

Youth For the Quality Care of Animals (YQCA)

YQCA is a national multi-species quality assurance program for youth ages 8 to 21 with a focus on three core pillars:

- Food safety
- Animal well-being
- Character development

Chapter 5: Calf and Heifer Management

Abbreviations

ADG – Average daily gain

AFC – Age at first calving

FPT – Failure of passive transfer

MBW – Mature body weight

Definitions

Cold calf housing – Housing in which the temperature varies with the outside temperature

Colostrum – First milk secreted after calving

Compensatory growth – Term used to describe a period of increased growth rate that follows a growth restriction imposed earlier in the heifer's life

Completion rate – Percentage of heifer calves that successfully reach maturity and enter the milking herd

Scours – loose manure that lasts for two or more days and can be accompanied by a decrease in appetite, lethargy, dehydration, and fever

Transition milk – Milk harvested from the second, third, and fourth milking after calving

Warm calf housing – Housing in which environmental temperature is controlled

Weaning – Act of taking a young animal off milk as the main source of nutrition

Project Selection

Important points to consider when selecting a calf as a project animal include:

- Age
- Breed
- Health
- Pedigree
- Conformation
- Price

Economics

Heifers account for 15 to 20 percent of total farm expenses on many dairy operations.

Feed costs account for 55 to 60 percent of the total cost of raising dairy replacement heifers.

Identification

Methods commonly used to identify calves include:

- Eartag
- Photo
- Sketch
- Tattoo
- Freeze branding

Liquid Diet

Liquid diet choices for pre-weaned calves include milk replacer, whole milk, and colostrum.

A pre-weaned calf should be fed 10-17 percent of its body weight in milk or milk replacer daily.

When a calf nurses, milk travels through the esophageal groove to the omasum and abomasum. It bypasses the rumen and reticulum. In a newborn calf, the reticulum and rumen are not yet fully developed.

The temperature of milk or milk replacer should be 100-105°F when it is delivered to preweaned calves.

Colostrum

Colostrum contains antibodies that provide immunity from disease for calves. It contains a higher level of protein than normal milk.

A newborn calf should be fed colostrum at an amount equal to 10 percent of the calf's bodyweight within the first two hours of life.

If colostrum is pasteurized, it should be heated to 140°F for 60 minutes.

Critical factors in colostrum management are quantity, quality, timing, and cleanliness.

Storage options for excess colostrum are:

- Add preservative acid
- Fermented
- Frozen
- Refrigerated

Frozen colostrum may be safely stored for a year.

The Brix refractometer and colostrometer are on-farm tools for estimating colostrum quality.

To be considered high quality, colostrum should have an IgG concentration of at least 50 grams per liter.

Conditions that can result in poor quality colostrum include:

- Cows is dry less than 3-4 weeks
- Pre-milking
- Leaking teats
- Dirty udder and teats
- Young cow

Milk Replacer

Conventional milk replacer should contain 20% crude protein and 20% fat.

Accelerated milk replacer should contain 26-30% crude protein and 15-25% fat.

Recommended protein sources for milk replacers are:

- Casein
- Modified wheat protein
- Dried skim milk
- Protein modified soy flour
- Dried whey
- Soy protein concentrate
- Dried whey product
- Soy protein isolate
- Dried whey protein concentrate

Weaning

Grain intake should be the main criterion used for deciding when to wean a calf.

Before weaning a calf should eat at least 2-3 pounds of grain per day for three consecutive days.

Calf Starter

Calf starter should contain at least 20% crude protein.

There are several types of calf starters available. They are:

- Commercial textured calf starters
- Homemade grind and mix starters
- Commercial pelleted starters

Growth

Calves should at least double their birth weight by 8 weeks of age.

Average daily gain (ADG) is a significant factor in monitoring growth rates in dairy heifers.

Body size is the most important factor to consider in determining when to breed a heifer for the first time.

Heifers usually show heats at 40% of mature bodyweight. They should start being bred at 55% of mature bodyweight and calve for the first time at approximately 82% of mature bodyweight.

Calf Housing and Environment

Calf housing should be clean, dry, draft-free and well ventilated.

The optimal temperature for calves in still air is 60°F.

The calf uses energy from her diet to stay warm when the air temperature falls below 50°F.

High temperatures also affect calves; temperatures over 85°F will increase breathing rate, cause sweating, and raise body temperature.

The optimum relative humidity for calf housing is 65-75 percent.

Systems of calf housing include:

- Calf hutches
- Pens on the floor
- Counter-slope system
- Elevated stalls
- Cold calf housing system

Advantages of calf hutches include:

- They are easily moved.
- They provide better ventilation.
- They prevent disease from spreading from one calf to another.
- They are cheaper than building a barn.
- They are easier to clean.

Calf Health

The leading causes of death in young calves are scours and pneumonia.

The major causes of calf scours include:

- Inadequate colostrum
- Overfeeding
- Overcrowding
- Poor quality colostrum
- Poor quality milk replacer
- Inadequate ventilation
- Unsanitary calving conditions

Physical factors contributing to pneumonia in calves are drafts, chilling, dampness, and poor ventilation.

A farmer might ultrasound a calf's lungs to detect pneumonia.

Places where pathogenic organisms may enter a newborn calf's body are the mouth, navel, and nose.

Signs of illnesses in calves include:

- Poor appetite
- Nasal discharge
- Lack of energy
- Cough
- Drooping ears
- Elevated temperature
- Watery manure
- Dull eyes

Either a 7% iodine solution or a 1:1 mixture of chlorhexidine and 70% alcohol should be applied on the calf's navel within 30 minutes after birth to seal the entrance from disease causing organisms.

Stress reduction is important for calf health and performance. Common calf stressors include:

- Changes in routine
- Feeding changes
- Housing changes
- Crowding
- Ear tagging
- Dehorning/disbudding
- Transporting
- Improper handling
- Extreme weather changes

A calf is 2 to 3 weeks old when it begins to chew its cud.

Calves should be dehorned before three weeks of age.

Methods of dehorning calves are:

- Dehorning paste
- Cutting or gouging (Barnes type dehorner)
- Electric

Extra teats are also known as supernumerary teats. Between 30 and 40 percent of heifers born have extra teats. Extra teats should be removed as soon as they can be identified but no later than onset of puberty.

Custom Heifer Rearing

Custom heifer growing offers several advantages to dairy producers who have been raising their own replacements including:

- Decreased labor requirement
- Increased milking herd management
- Increased facility capacity for milking cows
- Herd expansion without capital investment with use of existing facilities
- Increased feed inventory for milking cows
- Potential for better replacement heifers because of more specialized care and management

Major elements associated with a contract for raising dairy replacements are:

- Time period
- Amendments, renegotiations, and renewal
- Billing and payment procedures
- Conditions for termination of agreement
- Definition of each party's responsibility

Methods of charging for heifer grower services include:

- Per animal per day
- Per pound of gain
- Option to purchase
- Per animal
- Feed plus yardage

Chapter 6: Nutrition, Feeds, and Feeding

Abbreviations

AA – Amino acid

ADF – Acid detergent fiber

ADIN – Acid detergent insoluble nitrogen

ADP – Adenosine diphosphate

AMP – Adenosine monophosphate

ATP – Adenosine triphosphate

BCS – Body condition score

BHB – Beta hydroxybutyrate

BUN – Blood urea nitrogen

CF – Crude fiber

CP – Crude protein

DCAD – Dietary cation-anion difference

DE – Digestible energy

DM – Dry matter

DMI – Dry matter intake

FFA – Free fatty acid

GIT – Gastrointestinal tract

ME – Metabolizable energy

MUN – Milk urea nitrogen

NDF – Neutral detergent fiber

NDIN – Neutral detergent insoluble nitrogen

NE – Net energy

NEL – Net energy for lactation

NEFA – Non-esterified fatty acid

NFC – Non-fiber carbohydrates

NIR – Near-infrared reflectance

NPN – Nonprotein nitrogen

NSC – Nonstructural carbohydrates

PUN – Plasma urea nitrogen

RDP – Rumen-degradable protein

RFI – Residual feed intake

RFQ – Relative forage quality

RFV – Relative feed value

Definitions

Acid – A substance that has a low pH (below 7.0)

Alkaline – A substance that has a high pH (above 7.0)

Amino acids – Building blocks of true proteins

Anion – A negatively charged ion or particle

Annuals – Plants that are seeded each year and whose growth are completed in one crop year

Baleage – Wrapped, round bales of silage

Body condition scoring – A system to evaluate the thinness or fatness of dairy cattle

Buffer – Any substance that can reduce changes in pH when an acid or alkali is added

Cation – A positively charged ion or particle

Chyme – Feed material found in the small intestine

Crude protein – Total protein in a feed

Cud – Feed that a cow has regurgitated and is being re-chewed

Digestible energy – The total energy in a feedstuff minus the energy lost in feces

Dry matter – Portion of a feed that remains after water has been removed by drying in an oven

Eructation – Belching of gas by ruminant animals as a natural way for releasing gases produced during the fermentation process

Esophagus – Tube that connects the mouth to the rumen

Essential amino acids – Amino acids that must be provided in the diet

Fatty acids – Building blocks of fats and lipids

Forage - Vegetative portion of plants in a fresh, dried, or ensiled state that is fed to livestock

Functional amino acid – Amino acid that regulates important biological functions other than just serving as a building block for true proteins

Green chop - Forage harvested (cut and chopped) in the field and fed directly to livestock

Hay - Dried forage (grasses, alfalfa, clovers) used for feeding farm animals

Mastication - Chewing

Metabolizable energy - Digestible energy minus the energy lost in urine and gas

Negative energy balance - Occurs when the amount of energy taken into the body is less than the amount of energy required by the body

Net energy - Actual amount of energy the body can use for growth, lactation, reproduction, and body maintenance

Nonessential amino acids – Amino acids that are produced by the cow and do not have to be provided in the diet

Nutrient - Any chemical substance that provides nourishment to the body

Palatability - Taste or likability of a feedstuff

Papillae - Tiny, finger-like projections that line the wall of the rumen

Perennials - Plants that have a life cycle of more than two years

Pica – Condition when animals eat inanimate objects that are not feed, e.g., stone, soil

Rumen degradable protein - Protein or nitrogen that is degraded in the rumen by microorganisms and incorporated into microbial protein or freed as ammonia

Rumen undegradable protein - Protein that passes through the rumen and is unchanged by microbes; also called by-pass protein

Rumination - Process in ruminants when semi-liquid ingested feed is regurgitated into the esophagus, re-chewed, and re-swallowed for further digestion

Saliva - Watery substance formed in the mouths of animals, secreted by the salivary glands

Saturated fatty acids – Fatty acids that are completely hydrogenated; each carbon atom is associated with the maximum number of hydrogen atoms; they have no double bonds

Silage (ensilage) - Green forage that is chopped and put into a silo, where it is packed or compressed to exclude air and undergoes an acid fermentation (lactic and acetic acids) that retards spoilage

Total mixed ration - A blend of all feedstuffs (forages & concentrates) in one feed

Transition period - Period from three weeks prior to calving to three weeks after calving

Unsaturated fatty acids – Fatty acids that are not completely hydrogenated; they have one or more double bonds

Villi - Small projections that line the small intestine wall

Saliva

Saliva is the major buffer for maintaining optimum rumen pH.

The mature dairy cow produces 50 to 80 quarts of saliva per day.

The functions of saliva are to:

- Moisten food
- Provide fluid base for many nutrients
- Lubricate food
- Provide the proper environment for bacterial growth
- Act as a buffer

Ruminant

The dairy cow is a ruminant, meaning it has a four-compartment stomach.

The stomach compartments are the reticulum, rumen, omasum, and abomasum.

Reticulum

The reticulum is also known as the honeycomb.

The reticulum is the stomach compartment located closest to the heart.

Hardware disease occurs in the reticulum.

Rumen

The rumen is also known as the fermentation vat.

The rumen is the largest of the cow's stomach compartments. It makes up 25% of the newborn calf's stomach capacity and 80% of the mature cow's stomach capacity.

Heifers have a fully functional rumen by 6 to 8 months of age.

Fermentation is the primary process that takes place in the rumen.

Bacteria, fungi, and protozoa are types of organisms that live in the rumen and digest feed.

Carbon dioxide and methane are gases produced in the rumen.

The ideal rumen pH is 5.9 to 6.2. The rumen is acidotic when rumen pH drops below 5.9.

Omasum

The omasum is also called manyplies.

The main function of the omasum is the dehydration of partially digested feed.

Abomasum

The abomasum is the enzyme and acid secreting portion of the ruminant stomach.

The abomasum is also called the true stomach.

The primary acid found in the abomasum is hydrochloric acid.

Small Intestine

The segments of the small intestine are the duodenum, jejunum, and ileum.

Fats are broken down in the small intestine.

The liver is the first organ to receive blood from the small intestine.

The pancreas secretes digestive enzymes into the small intestine.

Large Intestine

The main functions of the large intestine are water absorption and storage of waste materials.

Nutrients

The main processes for which a cow uses nutrients from her feed are:

- Maintenance
- Growth
- Production
- Reproduction

The nutrients contained in feedstuffs are:

- Carbohydrates
- Fats
- Protein
- Minerals
- Vitamins
- Water

Energy

Major sources of energy for the dairy cow are fats and carbohydrates.

Energy is most likely to be the limiting nutritional requirement for the high producing dairy cow.

A calorie is a unit of measure of energy in a feed; it is the amount of energy required to raise 1 gram of water 1°C.

Fats

Fats are the most concentrated energy source in dairy cattle rations. They contain 2.25 times the energy value of carbohydrates.

The recommended maximum level of fat in a lactating cow's ration is 5 to 7% of ration dry matter.

The forms of fat used in dairy cattle rations include animal fats (tallow), protected fats (calcium soaps), and whole oil seeds (whole cottonseed, whole soybeans).

Whole oil seeds contain high levels of unsaturated fatty acids.

Carbohydrates

The basic elements contained in carbohydrates are carbon, hydrogen, and oxygen.

Cellulose and hemicellulose are structural carbohydrates that the cow can use as a source of energy.

Starch, sugar, and pectin are nonstructural carbohydrates that are highly digestible parts of feeds.

Volatile Fatty Acids

Volatile fatty acids are the main products of carbohydrate digestion by rumen microorganisms.

The main volatile fatty acids produced in the rumen are:

- Acetic acid (acetate)
- Butyric acid (butyrate)
- Propionic acid (propionate)

Acetic acid is the primary source of energy and milkfat.

Propionic acid is a precursor for glucose; it is produced from digestion of starch and grain.

Protein

The basic elements that are present in all proteins are:

- Carbon
- Hydrogen
- Oxygen
- Nitrogen

Most proteins contain 16% nitrogen.

To determine the crude protein content of a feed, multiply the nitrogen fraction by 6.25.

If a farmer said he was feeding a 16% dairy feed, the 16% is referring to crude protein.

Proteins derived from poultry, marine or vegetable sources may be used in ruminant rations.

Proteins derived from ruminant sources may not be used in ruminant rations because of concerns about Mad Cow Disease.

Amino Acids

There are 20 standard amino acids.

The cow's sources of amino acids are rumen undegradable protein and rumen microbes.

Amino acids are classified as essential or nonessential.

The ten essential amino acids for milking cows are:

- Arginine
- Histidine
- Isoleucine
- Leucine
- Lysine
- Methionine
- Phenylalanine
- Threonine
- Tryptophan
- Valine

The most limiting amino acids in dairy cattle nutrition are lysine and methionine.

Minerals

Macrominerals are generally required in relatively large quantities. Requirements are usually stated as a percent of ration dry matter. The macrominerals are:

- Calcium
- Magnesium
- Potassium
- Sulfur
- Chlorine
- Phosphorus
- Sodium

Potassium is the mineral needed by the dairy cow in the largest quantity.

Microminerals (trace minerals) are required in relatively small quantities. Requirements are usually stated in parts per million (ppm). The microminerals are:

- Cobalt
- Iodine
- Manganese
- Zinc
- Copper
- Iron
- Selenium

Vitamins

Vitamins are classified as either fat-soluble or water-soluble.

The fat-soluble vitamins are:

- Vitamin A
- Vitamin D
- Vitamin E
- Vitamin K

Beta-carotene, found in most legumes and grasses, is a precursor of Vitamin A.

Vitamin E has functions like selenium.

Vitamin K plays a role in the coagulation of blood.

The water-soluble vitamins are the B complex vitamins and Vitamin C.

The B Complex vitamins are:

- Thiamine (B1)
- Niacin (B3)
- Biotin (B7)
- Choline
- Riboflavin (B2)
- Pantothenic Acid (B5)
- Folic Acid (B9)
- B12

Vitamin C is also known as ascorbic acid.

Vitamins are measured in International Units (IU).

Water

Physiological functions of water in the body include:

- A medium to transport nutrients
- To carry waste products to the point of excretion
- Functions as a universal solvent
- To cool the body at high environmental temperatures
- Serves as a fluid to lubricate joints
- Serves as a substrate for metabolic reactions
- Serves as a fluid base for milk

An average dairy cow drinks 30 to 50 gallons of water each day.

Peak times for water consumption are as soon as cows leave the milking parlor and when cows consume large amounts of dry matter (at feeding).

Performance (growth or milk production) will be reduced the quickest through a lack of water as compared to other nutrients.

A dairy cow excretes or loses water through breathing, feces, milk, sweat, and urine.

Factors influencing the amount of water consumed by dairy cattle include:

- Body size
- Water quality
- Diet
- Environmental temperature
- Relative humidity
- Milk production
- Water temperature
- Water availability

Fiber

Fiber is needed in dairy cattle rations to:

- Maximize dry matter and energy intakes
- Maintain normal milk fat percentage
- Maintain normal rumen function
- Protect against post-calving difficulties

Digestibility of plant fiber decreases as the plant increases in age and/or in hot weather.

Acid detergent fiber (ADF) consists of cellulose, lignin, and lignified nitrogen components (heat damaged protein).

The acid detergent fiber content of a high producing cow's ration should be 18-21%.

Neutral detergent fiber (NDF) is used to predict feed intake. The compounds that make up neutral detergent fiber (NDF) are cellulose, hemicellulose, and lignin.

Nutrient Requirements

Many factors are required to determine nutrient requirements of a lactating cow including:

- Body weight
- Fat test
- Body condition
- Age
- Stage of lactation
- Environmental temperature
- Milk production level
- Reproductive status

Legumes

Legumes used in dairy rations include:

- Alfalfa
- Clover
- Peanuts
- Soybeans
- Bird's Foot Trefoil
- Lespedeza
- Peas
- Vetch

Nitrogen fixing bacteria are associated with legumes.

Phosphorus is critical for the establishment of legumes.

Hay

Immature hay is more valuable as a feed for dairy cows than mature hay because of:

- Higher nutrient content
- Greater palatability
- Higher digestibility
- Lower fiber

Relative feed value (RFV) combines digestibility and intake estimates into one number for an easy and effective way to identify and market quality hay. RFV is expressed as a percent compared to full bloom alfalfa at 100 percent RFV.

Grazing

The most common reason that farm owners adopt grazing is cost reduction. The main costs cited for reduction are feed and labor.

Advantages of intensive rotational grazing include:

- Low input costs
- Even manure distribution
- Improved weed control
- Low labor requirement
- Reduced soil erosion

Disadvantages of grazing include:

- Inconsistent quality
- Unable to balance ration properly
- Distance from parlor
- Inconsistent quantity
- Lower forage yield per acre

Silage

Phases of silage fermentation are:

- Aerobic
- Anaerobic
- Stable
- Feeding

Types of silage storage facilities include:

- Bunker silo
- Upright/tower silo
- Oxygen limiting silo
- Trench silo
- Plastic bag

The minimum recommended feeding rate from an upright silo is 2-4 inches per day in the winter and 4-6 inches per day in the summer. It is at least 6 inches per day for bunker silos.

Plastic is generally considered the best material for covering a bunker silo.

Even distribution of silage within the silo to exclude air is an important part of making good quality silage.

Valuable nutrients that can be lost in seepage from a silo are minerals, organic acids, protein, and soluble sugars.

Lactic acid is the most desirable acid produced during ensiling. Butyric acid is an undesirable acid.

Heat damage in haylage is indicated by dark color and burnt odor.

Corn Silage

Corn silage has the best fermentation and preservation characteristics with minimal seepage when harvested at 35% dry matter.

The desired pH or properly fermented corn silage is 4.0 or less.

Cold flow ammonia may be added to corn silage to increase the crude protein content.

Kernel processing of corn silage increases starch digestibility.

The recommended theoretical length of cut (TLC) for corn silage harvested with a conventional harvester is ⅜ inch. If harvested with a harvester fitted with a kernel processor, TLC should be ¾ inch.

Characteristics of corn that have been introduced through transgenics include:

- Corn borer resistance
- Herbicide resistance
- High oil content
- Waxy corn

Bt corn hybrids were genetically engineered to provide resistance to the European corn borer.

Brown midrib corn, sorghum, and pearl millet varieties have lower lignin concentrations, which increase fiber digestibility.

By-Product Feeds

By-products can be successfully used as feed for dairy cattle. Before including a byproduct in the ration, the following factors should be considered:

- Nutrient composition
- Availability
- Storage
- Ability to feed/use
- Cost
- Palatability
- Consistency

By-product feedstuffs include:

- Bakery waste
- Citrus pulp
- Cottonseed hulls
- Cottonseed meal
- Distillers grains
- Dried brewers grain
- Hominy feed
- Peanut meal
- Soybean hulls
- Soybean meal
- Wet brewers grain
- Wheat middlings
- Whole cottonseed

Forage Testing

Forage testing is the most reliable way of knowing the nutrient content of forages.

Forage testing methods include NIR and wet chemistry.

A forage analysis report commonly contains:

- Dry matter
- Total digestible nutrients
- Neutral detergent fiber
- Crude protein
- Net energy lactation
- Ash (mineral matter)
- Soluble protein
- Acid detergent fiber

When sampling square bales of hay for forage testing, 20 bales should be sampled.

A dry matter determination may be done quickly and easily on a forage sample at home using a microwave oven, gram scale, paper plate and water glass.

Forage Particle Separator

A forage particle separator can be used to:

- Evaluate whether there is enough long fiber in the ration
- Check for over mixing and particle size reduction
- Develop baseline particle size information for comparison
- Check ration uniformity
- Determine optimum mixing order
- Evaluate whether particle size changes with hay quality
- Check for sorting

Ionophores

Ionophores alter rumen fermentation by boosting the production of propionic acid and reducing the production of acetic acid.

Examples of ionophores are Lasalocid and Monensin. Monensin is approved for use in lactating dairy cattle, but Lasalocid is not.

Mineral Supplements

Common mineral supplements include:

- Dicalcium phosphate
- Magnesium oxide
- Potassium chloride
- Limestone
- Monocalcium phosphate
- White salt

Limestone is an excellent source of calcium.

Magnesium oxide is the most fed source of magnesium.

Buffers

Reasons one might add buffers to a dairy cow's ration include:

- Increase fat test
- Improve digestibility
- Aid in adjusting to high-energy ration
- Maintain acid-base balance
- Improve milk quality
- Improve intake

Buffers commonly used in dairy rations include:

- Limestone (calcium carbonate)
- Sodium bentonite
- Magnesium oxide
- Sodium bicarbonate

Dietary Cation-Anion Difference

Dietary Cation-Anion Difference (DCAD) is a helpful tool to prevent milk fever.

The elements used to calculate DCAD are:

- Sodium (+)
- Potassium (+)
- Chlorine (-)
- Sulfur (-)

Ionic salts are used in pre-fresh cow rations to help prepare cows for the sudden demand for blood calcium. Examples are:

- Ammonium chloride
- Calcium chloride
- Magnesium chloride
- Ammonium sulfate
- Calcium sulfate
- Magnesium sulfate

Feeding

Advantages of feeding a total mixed ration (TMR) include:

- Eliminate selective feeding
- Lower percent fiber needed in ration
- Consistent ration
- Easier to balance precisely
- High dry matter intake
- Fewer digestive upsets
- Free-choice mineral not needed
- Can feed a variety of by-products
- Higher milk production

Advantages of automated feed pushing include:

- Consistency
- Reduced feed refusals
- Increased butterfat content
- Minimized sorting
- Improved performance of timid cows

Feed bunks for the milking herd should be cleaned out daily to remove refusals.

Grouping

When grouping the milking herd, several factors may be considered including:

- Body condition
- Production level
- Stage of lactation
- Lactation number
- Reproductive status
- Health

Benefits of grouping first lactation cows separate from older cows include:

- Less competition
- Tailored management
- Limited stress

Body Condition Scoring

Body condition scoring, based on a five-point scale, can be used to evaluate nutrition and health. A score of 1 is given to a very thin cow; a score of 5 is given to a very fat cow.

Table 6. Targets for body condition scores (BCS) at different stages of lactation

Lactation Stage	Target BCS
At calving	3.0-3.25
Early lactation	2.5
Mid lactation	2.75
Late lactation	3.0
Drying off	3.0-3.25

Milk Urea Nitrogen

Milk urea nitrogen (MUN) shows how well nitrogen and fermentable carbohydrates are balanced in the ration.

The desirable range for MUN is 8 to 12 mg/dL.

- If MUN is below 8 mg/dL, there is a risk of low rumen ammonia, which can reduce rumen microbial growth.
- If MUN is over 12 mg/dL, there may be nitrogen losses through urine that raise environmental concerns.
- If MUN is over 16 mg/dL, there may be negative impacts on reproduction.

Miscellaneous

A mature dairy cow has 32 teeth but has no upper front teeth.

Feed is the largest cost in milk production.

Molasses is often added to dairy cattle rations to improve taste (palatability) and reduce dustiness.

Raw soybeans will turn rancid if they are ground.

Peak milk production usually occurs 2-3 weeks before peak feed intake.

Bovaer is an FDA-approved feed ingredient that reduces methane emissions from cows and other ruminants.

Chapter 7: Lactation, Milking, and Udder Health

Abbreviations

BST – Bovine somatotropin

BTMC – Bulk tank milk culture

BTSCC – Bulk tank somatic cell count

CFM – Cubic feet per minute

CIP – Clean in place

CMT – California mastitis test

CNS – Coagulase-negative staphylococci

DMSCC – Direct microscopic somatic cell count

IGF – Insulin-like growth factor

IMI – Intramammary infection

rBST – Recombinant bovine somatotropin

SCC – Somatic cell count

SCS – Somatic cell score

WMT – Wisconsin mastitis test

Definitions

Acute mastitis – Mastitis characterized by sudden onset, redness, swelling, hardness, pain, grossly abnormal milk, and reduced milk yield

Agitator – Stirs milk in the bulk tank to help with cooling and to provide a uniform product mixture for sampling

Air injector – Device that allows controlled, cyclic admission of air during cleaning and sanitizing to produce slug flow conditions

Alternating pulsation – When cyclic movement of the liners of two teat cups within a cluster alternate with the movement of the other two liners

Alveoli – Spherical clusters of secretory cells in the mammary gland that are arranged in grape-like structures

Backflushing – System for sanitizing teat cup liners between cow milkings

Bimodal letdown – Condition when milk flow peaks two separate times during milking primarily due to inadequate stimulation of the cow's udder before attaching the milking unit

Bulk tank – A large storage tank for cooling and storing milk at a cold temperature until it is transported to a processing plant; usually made of stainless steel

Chronic mastitis – Mastitis that continues over a long period of time, with progressive development of scar tissue and simultaneous reduction in milk yield

Clean-in-place – Capability to clean and disinfect the milk-contact components of a milking system by circulating appropriate solutions through them without disassembly

Clinical mastitis – Mastitis characterized by visible abnormalities in the udder or milk

Foremilk – First streams of milk stripped from the udder prior to milking

Forestripping – Process by which the first few streams of milk are removed from the teat prior to milking to observe for abnormalities and to flush the teat canal

Inflammation – Condition in which the cow's body seeks to eliminate or neutralize invading microorganisms and repair damaged tissue.

Intramammary infection – Infection characterized by the presence of microorganisms growing in the udder

Involution – Process by which udder tissue goes back to a non-milk-producing state after drying off

Keratin – Waxy substance produced by cells lining the teat canal that serves as a plug between milkings and aids in reducing penetration by microorganisms

Lactation – Period when a cow is in milk

Latency period – Time between the completion of tactile stimulation and attachment of the milking unit

Liner slip – Condition whereby a teat cup slides down the surface of the teat, often accompanied by a squawk

Looped milk line – Milk line that forms an enclosed circuit with two full-bore connections to the receiver

Lowline milking system – System in which the milk inlet to the milk line or receiver jar is below the animal standing level

Mastitis – An inflammation of the udder, most caused by infecting microorganisms

Milk letdown – Process through which milk is squeezed out of milk-producing tissue by the action of the hormone, oxytocin

Milk line – Line that carries milk and air during milking and has the dual function of providing milking vacuum and conveying milk to a receiver

Milk meter – Device between the cluster and the milk line for measuring all the milk from an individual animal

Milk stone – Milk-mineral deposit on milk handling equipment

Myoepithelium – Contractile tissue that forces milk out of the alveoli upon action of oxytocin

Preparation lag time – Time between the first tactile stimulation and attachment of the milking unit

Pulsation – The cyclic opening and closing of a teat cup liner

Pulsation rate – The number of times per minute that the pulsator opens and closes

Pulsation ratio – The amount of time a pulsator creates vacuum to open the liner compared with the amount of time it admits air to collapse the liner

Pulsator – The part of the milking system that causes the alternate vacuum pressure between the teat cup shell and liner

Residual milk – Milk remaining in the mammary gland following completion of milking

Ropy milk – Milk that contains strings of white blood cells

Sanitary trap – Vessel between the milk system and the air system to limit movement of liquids and other contaminants between the two systems

Sanitizer – Chemical solution used to kill bacteria on product contact surfaces

Somatic cell count – Measurement most used as an indicator of mastitis; an indicator of the extent of subclinical mastitis present in a cow's udder or number of leukocytes present

Spontaneous recovery – Ability of a cow to cure itself of an udder infection without the aid of antibiotics or other drugs

Stray voltage – Small electric currents that flow through the electrical grounded-neutral system and that pass through a cow's body, adversely affecting her behavior and performance

Strutting – Condition in which the teats point out too much

Subclinical mastitis – Mastitis with no detectable change in the udder itself and no observable abnormality of the milk

Vacuum gauge – An instrument to indicate the level of vacuum in the system relative to atmospheric pressure

Vacuum pump – An air pump that produces vacuum in the milking system

Vacuum regulator – The part of the milking system that prevents the vacuum level from exceeding a prescribed level; also called vacuum controller

Wash line – Line that carries cleaning and sanitizing solutions during the cleaning process from the wash sink, vat, or tank to the milking units, milk line or milking vacuum line

Hormones

Adrenaline (epinephrine) can interfere with milk ejection when a cow becomes frightened or upset. Inhibitory effects of adrenaline can last 20 to 30 minutes.

Oxytocin is the hormone that causes milk letdown. It is produced by the hypothalamus but secreted from the posterior pituitary. Maximum oxytocin concentration in blood occurs one minute after beginning stimulation.

Prolactin is the pituitary hormone that is critical in the initiation and maintenance of lactation.

Estrogen and progesterone are ovarian hormones that are involved in the development of the mammary gland.

Milk Production

The parts of the teat through which milk passes are the teat cistern, sphincter muscle, and streak canal (teat canal).

Cows milked three times a day will normally produce 8 to 15 percent more milk than cows milked twice a day.

Cows calving in November, December, and January have the highest 305-day milk production.

Milking Facilities

Types of milking parlors include:

- Herringbone
- Parallel
- Parabone
- Rotary
- Side opening

The efficiency of rotary parlors is influenced by:

- Number of stalls
- Length of milking
- Platform speed
- Number of workers

The most common platform speed used in rotary parlors is 5 seconds per stall.

Automatic milking systems milk cows without human labor. Other names for automatic milking systems are voluntary milking systems and robotic milking.

Milking Equipment

Parts of a milking unit include the claw, teat cup shell, teat cup liner (inflation), milk tube, and short air tube.

Teat cup liners (inflations) should generally be replaced every 1,000 - 1,200 cow milkings.

Specifically, the teat cup liner (inflation) is the only part of the milking system that touches the cow.

Signs of a malfunctioning milking system include:

- Excessive vacuum fluctuation
- Slow milking
- Teat cups fall off
- Flooded milk lines
- Squawking teat cups
- Uneven milk flow

A liner slip may be caused by:

- Improper liner design
- Vacuum fluctuations
- Cluster weight
- Milking wet teats
- Old, worn-out liners

Vacuum pressure at the teat end at the time of milking should be 12 to 13 inches of mercury.

Cleaning Equipment

A standard milking equipment cleaning protocol consists of four phases:

- Pre-rinse
- Chlorinated alkaline cleaning
- Acid rinse
- Sanitization

The key factors for adequate, effective cleaning of milking systems are:

- Contact time
- Water temperature
- Chemical concentration

Recommended temperature of water for washing the bulk tank, lines, and other equipment is 160°F.

Dirty equipment is most frequently the cause of high bacteria counts in milk.

Milking Procedures

The recommended milking procedures are:

1. Provide a clean, low stress environment for cows.
2. Check foremilk and udder for mastitis.
3. Pre-dip teats in an effective product and provide a 20 to 30-second contact time.
4. Dry teats completely with an individual towel.
5. Attach milking unit within 1 minute after the start of stimulation.
6. Adjust units as necessary for proper alignment.
7. Shut off vacuum before removing unit.
8. Dip teats immediately after unit removal with an effective product.

Consequences of long pre-milking stimulation include:

- Lower production
- Higher somatic cell count (mastitis problems)
- Slower milking time

Teat Dips

When using a teat dip as a pre-dip, the dip should be left on the teat for at least 20 to 30 seconds before it is wiped off.

The main reason for teat dipping after each milking (post-dipping) is to reduce the rate of new infection in the udder.

Solutions commonly used as teat dips include:

- Bronopol
- Chlorhexidine
- Chlorine
- DDBSA
- Hydrogen peroxide
- Iodine
- Quaternary ammonia

Cloth Towels

When using cloth towels in udder preparation, the following guidelines are recommended:

- Use a separate towel for each cow.
- Wash cloth towels using warm water.
- Do not let damp towels sit between uses because of yeast or mold contamination.
- Dry towels immediately after washing or add bleach when washing.

Mastitis

The major factors involved in bovine mastitis are the cow, microorganisms, and environment.

Mastitis is the costliest disease in dairy cattle. Economic losses due to mastitis are estimated to be about $200 per cow per year.

Mastitis-related costs include:

- Reduced milk production (64%)
- Drugs (5%)
- Discarded milk (14%)
- Veterinarian (3%)
- Early cow replacement cost (8%)
- Labor (1%)
- Reduced cow sale value (5%)
- Lost milk premiums (variable)

The main types of mastitis are subclinical mastitis, clinical mastitis, acute mastitis, and chronic mastitis.

Symptoms of clinical mastitis include:

- Flakes
- Stringy milk
- Hot quarter
- Presence of blood
- Clots
- Watery milk
- Swollen quarter

On-farm screening tests to detect mastitis include:

- California Mastitis Test
- Conductivity
- Strip cup

Potential causes of mastitis include:

- Failure to teat dip
- Poor housing/environment
- Poor sanitation
- Faulty milking equipment
- Poor milking practices
- Stray voltage
- Improper dry cow management

The most effective measures to prevent new mastitis infections are teat dipping and dry cow antibiotic treatment.

The streak canal (teat canal) is the cow's first line of defense against mastitis infections; leukocytes are the second natural line of defense.

Steps in a good mastitis control program are:

- Use functionally adequate milking equipment in the correct manner.
- Dip teats after milking with an effective product.
- Treat clinical cases immediately with recommended dosages.
- Treat every quarter of every cow at dry off with an effective dry cow product.
- Cull chronic cows.

Somatic Cells

High numbers of somatic cells in milk are generally an indicator of infection (mastitis).

Somatic cells include two types of cells:

- White blood cells (leukocytes) that move into the udder during inflammation
- Epithelial cells from milk producing tissues

Normal milk generally has a SCC less than 200,000 cells/milliliter.

The legal limit for somatic cell counts in raw milk in the United States is 750,000 cells/ml. The limit in the European Community is 400,000 cells/ml.

U.S. milk and milk products exported to European Union member countries must have a rolling average somatic cell count less than 400,000 cells/ml.

Mastitis-Causing Pathogens

Culturing milk samples (on-farm or in a lab) can provide information for mastitis prevention, treatment, and control by identifying the mastitis-causing pathogen.

Contagious mastitis-causing pathogens are those growing in the udder that are spread from cow to cow. Examples include:

- Staphylococcus aureus (Staph. aureus)
- Mycoplasma species
- Streptococcus agalactiae (Strep. ag.)

Environmental mastitis-causing pathogens grow in the cow's environment and contact the udder and teats causing infection. They include bacteria classified as coliforms or environmental Streptococci.

Coliforms include:

- Escherichia coli (E. coli)
- Enterobacter species
- Klebsiella species

Environmental Streptococci include:

- Streptococcus dysgalactiae
- Streptococcus uberis

Sources of environmental bacteria in dairy herds are:

- Soil
- Bedding
- Mud
- Water
- Feedstuffs
- Feces

Factors affecting the dairy cow's environment are:

- Climate
- Herd size
- Frequency and length of confinement housing
- Season of year
- Housing type
- Management of cows and facilities

Prototheca mastitis is caused by colorless algae.

Many other pathogens may cause mastitis including other bacteria, fungi, and yeast.

Milk Quality and Composition

The legal limit for bacteria counts in raw milk in the U.S. is 100,000 cfu/ml.

Sources of on-farm milk contamination include:

- Air (dust)
- Dirt (outside of the cow)
- Feed
- Interior of udder
- Antibiotics
- Equipment
- Insects
- Water

Factors that can influence milk composition include:

- Age of cow
- Breed
- Environmental temperature
- Estrus
- Genetics
- Milking procedures
- Nutrition
- Season
- Somatic cell count
- Stage of lactation

Conditions that will cause a decrease in fat test include:

- Finely chopped feeds
- Extremely hot weather
- Estrus
- Low fiber content in ration
- Illness

Mastitis and Milk Composition

Components that decrease in concentration in mastitic milk are:

- Calcium
- Casein
- Fat
- Lactose
- Phosphorus
- Potassium
- Solids not fat
- Total proteins
- Total solids

Components that increase in concentration in mastitic milk are:

- Chloride
- Immunoglobulins
- Leukocytes
- Lipase
- Sodium
- Trace Minerals

Dry Period

The traditionally recommended length of the dry period for dairy cows is 45 to 60 days.

The most effective time to treat mastitis infections is at drying off.

The purposes of dry cow antibiotic treatment are to remove existing infections and prevent new infections.

Benefits of dry cow antibiotic treatment include:

- Higher concentration of antibiotics than lactating products
- Antibiotics remain in the udder longer
- No discarding of saleable milk
- Cure of existing infections
- Prevention of new infections

Blanket dry cow therapy is the practice of treating every quarter of every cow at drying off.

Selective dry cow therapy is the practice of treating only cows that are at higher risk of an intramammary infection at drying off. Selective dry cow therapy is a way to decrease the use of antibiotics in food animals.

Herds considering a selective dry off program may want to evaluate the following before implementation:

- Bulk tank SCC
- Individual cows' monthly SCC tests
- Mastitis detection proficiency
- Culture results from clinical mastitis cases
- Contagious mastitis pathogen presence in the herd
- Dry off protocol adherence

In herds with a selective dry off program, the following information may be used to identify cows that could be omitted from treatment:

- SCC
- Cases of clinical mastitis in past 90 days
- California Mastitis Test (CMT) score at drying off

Chapter 8: Milk and Dairy Products

Abbreviations

ADV – Acid degree value

CFU – Colony forming units

CLA – Conjugated linoleic acid

HACCP – Hazard Analysis and Critical Control Points

HTST – High temperature, short time

LPC – Lab pasteurization count

NFDM – Nonfat dry milk

PI – Preliminary incubation

PMO – Pasteurized Milk Ordinance

RDA – Recommended Daily Allowance

SNF – Solids not fat

SPC – Standard plate count

TS – Total solids

UF – Ultrafiltration

UHT – Ultra high temperature

Definitions

A2 milk – Cow's milk that contains only the A2 variant of beta-casein protein (A1 is the other variant)

Acid degree value – Test that detects rancidity in milk

Casein – The primary protein found in milk

Churning – Process that turns cream into butter

Clarification – Process that removes solid impurities from milk prior to pasteurization

Cream – High fat milk product separated from milk

Cryoscope – Instrument used to test the freezing point of milk to determine if water has been added

Cultured dairy products – Dairy foods that have been fermented with lactic acid bacteria

Fortification – Process by which vitamins are added to milk

Hazard Analysis and Critical Control Points – System of quality control that identifies where mistakes often occur

Lactase – Enzyme needed by humans to digest lactose

Lactose – Milk sugar that gives milk its sweet flavor

Lactose intolerance – Condition when a person cannot break down milk sugar

Lipase – Enzyme that breaks down butterfat, leading to rancidity

Pasteurization – Process that destroys any disease-producing bacteria that might be present in raw milk

Phosphatase test – Test used to determine if raw milk has mixed with pasteurized milk

Raw milk – Milk as it comes from the cow prior to processing

Rennet – Substance containing many enzymes that is obtained from the lining of a calf's stomach

Rennin – Enzyme found in rennet that is used to coagulate protein (casein) when making cheese

Separation – Process of dividing milk into skim milk and cream

Standard plate count – Test that measures bacterial content of raw milk to monitor milk quality

Standardization – Process that assures that milk and dairy products will be uniform in protein and fat content

Whey – Fluid by-product of cheesemaking

Milk

Milk is nature's most nearly perfect food.

Milk is 96-98% digestible.

Animals other than the cow are also used to produce milk for human consumption throughout the world. These animals include the goat, sheep, camel, water buffalo, reindeer, horse, and yak.

Cow's milk consists of 87.4% water and 12.6% milk solids.

Milk solids can be divided into solids-not-fat (8.9%) and fat (3.7%).

Components of the solids-not-fat part of milk are protein (3.4%), lactose (4.8%), and minerals (0.7%).

The minimum total solids-not-fat content in the legal definition of milk is 8.25%.

Protein

Milk contains casein and whey proteins.

Milk taste improves as the protein level in milk increases.

Lactose

Lactose is the major solids component of milk.

The simple sugars that make up lactose are glucose and galactose.

Vitamins And Minerals

Vitamin D is added to milk at processing time to prevent rickets. It is essential for efficient use of calcium and phosphorus in bone growth.

Reduced fat (2% fat), low-fat (1% fat), and skim milk must be fortified with Vitamin A to be nutritionally like whole milk.

The minerals found in milk that are important in bone growth are calcium and phosphorus.

Conjugated Linoleic Acid

Conjugated linoleic acid (CLA) is an 18-carbon fatty acid present in milk, particularly from cows grazing pasture, which has been found to have cancer prevention effects.

CLA content is greater in higher fat products.

Milk Quality

Advantages of high-quality milk from a processor's point of view include:

- Improved flavor
- Long shelf life
- Increased cheese yield
- Reduced hauling and handling costs due to low quality milk not having to be diverted to an alternative use

Advantages of high-quality milk from a dairy producer's point of view include:

- Greater profitability
- Increased milk yield
- Low culling rates
- Low treatment costs
- Reduced labor and labor cost
- Larger milk checks due to improved milk per cow and premiums

On-Farm Milk Storage

A bulk tank should be washed and sanitized every time it is emptied.

Grade A raw milk must be cooled to 45°F or less within two hours after milking.

After the first milking, the temperature of milk in a bulk tank should not reach higher than 50°F at any time.

Milk temperature should be kept under 40°F to maintain the best quality.

Milk Quality Tests

Raw milk quality tests used by milk plants include:

- Acid degree value
- Antibiotic test
- Flavor
- Freezing point
- Leukocyte (somatic cell) count
- Preliminary incubation (PI) count
- Sediment test
- Standard plate count

Off-Flavors

Common off flavors in milk are:

- Acid
- Bitter
- Cooked
- Feed
- Fermented
- Foreign
- Fruity
- Lacks freshness
- Oxidized
- Rancid
- Salty
- Sour

Off-flavors in milk are most found in the butterfat component.

An oxidized flavor can result from exposing milk to:

- Sunlight or fluorescent lighting (Light-oxidized)
- Copper bearing surfaces (Metal-oxidized)

Pigmented milk cartons are used to prevent an oxidized flavor.

A sour flavor occurs when there are large numbers of bacteria present in milk.

Antibiotic Residues

Antibiotic residues are not allowed in milk for human consumption. Reasons for this regulation include:

- Some people are allergic to antibiotics. (Main reason)
- Milk that contains antibiotic residues is not good for cheese making.
- Bacteria may become resistant to antibiotics.
- Antibiotics are not a natural part of milk.

Pasteurization

Pasteurization increases the shelf life of milk by greatly reducing the total bacteria population.

The batch or holding method of pasteurization heats milk to 145°F for not less than 30 minutes.

The high temperature, short time method of pasteurization heats milk to 161°F for 15 seconds.

Beverage Milks

Table 7. Milk labeling standards

Label	Other Names	Fat (g/cup)	Calories per cup
Fat free	Nonfat, skim	0	80
Low fat	1% fat	2.5	100
Reduced fat	2% fat	5	120
Whole		8	150

Titanium dioxide is often added to fat free milk to whiten the milk.

Butter

It takes 21.2 pounds of whole milk to make a pound of butter.

Butter must contain a minimum of 80% fat.

U.S. Grade AA is the highest grade of butter sold in the U.S.

One stick of butter = 1/2 cup = 1/4 pound = 8 tablespoons

California is the top butter-producing state.

Cream

Cream must contain at least 18% milk fat.

Cream varieties include:

- Acidified sour cream
- Acidified sour half & half
- Cream in aerosol cans
- Half & half
- Heavy cream
- Light cream
- Light whipping cream
- Reduced-fat sour cream
- Sour cream
- Sour half & half

Cheese

It takes 10 pounds of whole milk to make a pound of cheese.

The protein content of milk most affects the amount of cheese one can get from a unit of milk.

The major components of dried whey are lactose, minerals, and protein.

Cheese is classified according to its consistency. The classes are soft, semi-soft, hard, and very hard.

Mozzarella cheese is the most popular variety of cheese in the United States. Cheddar is second.

Feta and Roquefort are cheeses made from the milk of animals other than the dairy cow.

Top five states for total cheese production in 2024:

1. Wisconsin
2. California
3. Idaho
4. New Mexico
5. New York

There were 509 cheese plants in the U.S. in 2024.

U.S. cheese production totaled 14.25 billion pounds in 2024.

The dairy product that uses the biggest share of milkfat produced in the U.S. is cheese.

The winner of the 2024 World Championship Cheese Contest was *Hornbacher* from Switzerland. The contest is held biennially.

Frozen Dairy Products

Frozen dairy products include ice cream, frozen custard, sherbet, and frozen yogurt.

It takes 12 pounds of whole milk to make a gallon of ice cream.

Federal standards require ice cream to contain a minimum of 10% milk fat and 20% total milk solids by weight.

Some premium ice creams contain 16% milk fat.

Cultured Dairy Products

Cultured dairy product examples include:

- Acidophilus milk
- Buttermilk
- Crème fraiche
- Kefir
- Sour cream
- Yogurt

Yogurt is a mixture of milk (whole, reduced-fat, low-fat, or nonfat) and cream fermented by a culture of lactic acid-producing bacteria. Yogurt contains at least 3.25% milk fat and 8.25% solids-not-fat.

Authentic Greek yogurt is made by straining yogurt using muslin or cheesecloth to remove whey from the yogurt to make it creamy and thick. It takes four pounds of milk to make one pound of authentic Greek yogurt.

Chapter 9: Milk Marketing

Abbreviations

COOL – Country of Origin Labeling

CWT – Cooperatives Working Together

DIPP – Dairy Indemnity Payment Program

DMC – Dairy Margin Coverage

DRP – Dairy Revenue Protection

NOP – National Organic Program

USMCA – United States-Mexico-Canada Agreement

WTO – World Trade Organization

Definitions

Fluid milk – Packaged dairy products used as beverage milks

Fluid products – Term traditionally used to define products including beverage milks, fluid cream items, and yogurts

Fluid utilization – Proportion of Grade A milk in a market used to produce fluid (Class I) milk

Mailbox milk price – Price for milk of average composition and is a weighted average for the market; accounts for all payments received for milk including performance bonuses and premiums; also accounts for all deductions such as promotion, hauling, capital retains, and cooperative dues

Manufacturers – Producers of cheese, butter, nonfat dry milk, and other storable dairy products

Manufacturing milk – Grade B milk or the Grade A milk used in the production of manufactured dairy products

Milk class – Describes how milk is used by the processor or in a marketing area

Processors – Firms that process raw Grade A milk into fluid products

Consumer Assurances

The expiration date on a milk carton is a customer's assurance of a fresh dairy product.

The "Real Seal" assures the customer that the product they are purchasing is a genuine dairy product made with milk from cows that were raised on U.S. dairy farms.

Federal Milk Marketing Orders

The Agricultural Marketing Agreement Act of 1937 provided for Federal Milk Marketing Orders.

The Secretary of Agriculture regulates Federal Milk Marketing Orders.

There are eleven Federal Milk Marketing Orders in the United States. Multiple component pricing is used in seven of the orders. The current Federal Milk Marketing Orders are:

- Appalachian
- Arizona
- California (most recent addition)
- Central
- Florida
- Mideast
- Northeast
- Pacific Northwest
- Southeast
- Southwest
- Upper Midwest

Milk Classes

Federal Milk Marketing Orders have four milk classes based on how milk is used by the processor or in a marketing area.

- Class I – Milk used for beverage milks
- Class II – Milk used for soft products (e.g., cottage cheese, ricotta cheese, ice cream mixes, sour cream, yogurt, and fluid cream)
- Class III – Milk used for cream cheese and other spreadable cheeses, and hard cheese of types that may be shredded, grated, or crumbled
- Class IV – Milk used for butter, any milk product in dried form, and evaporated or sweetened condensed milk

Milk Grades

Fluid grade (Grade A) milk is milk produced under sanitary conditions that qualify it for fluid consumption. Only Grade A milk is regulated under Federal Milk Marketing Orders.

The Pasteurized Milk Ordinance (PMO) is the document that establishes the standards for Grade A milk.

Manufacturing grade (Grade B) milk is milk not meeting the fluid grade standards. Less strict standards generally apply.

Futures and Options

Futures and/or options are traded daily at the Chicago Mercantile Exchange for the following dairy commodities:

- Butter
- Cheese
- Dry whey
- Milk
- Nonfat dry milk

Milk Cooperatives

The top five milk producing cooperatives in the U.S. based on member milk volume in 2024 were:

1. Dairy Farmers of America Inc.
2. Edge Dairy Farmer Cooperative
3. California Dairies Inc.
4. Land O'Lakes Inc.
5. Select Milk Producers Inc.

The top 50 cooperatives accounted for 82 percent of the milk produced in the U.S. in 2024.

Dairy Farmers of America (DFA) is the largest dairy cooperative in the U.S.

Dairy Farmers of America is the largest processor and distributor of milk and dairy products in the U.S.

Cooperatives Working Together

Cooperatives Working Together (CWT) is a dairy farmer-funded self-help program to address supply and demand imbalances that can depress milk prices. The CWT program focuses on providing export assistance.

CWT is operated within the structure of the National Milk Producers Federation.

CWT's funding comes from farmers who invest 4 cents per hundredweight of milk sold.

Trade

The United States-Mexico-Canada Agreement replaced the North American Free Trade Agreement (NAFTA).

The top five countries buying dairy products from the United States in 2024 were:

1. Mexico
2. Canada
3. China
4. Japan
5. South Korea

The top five countries selling dairy products to the United States in 2024 were:

1. Ireland
2. New Zealand
3. Italy
4. Canada
5. France

Top Global Dairy Companies

Lactalis is the top dairy company in the world based on dairy sales. The company's headquarters is in France.

Danone is the world's largest yogurt maker.

Fonterra Co-operative Group Ltd. in New Zealand is the world's largest private exporter of dairy products.

Dairy Promotion

Fifteen cents per hundredweight of milk sold are deducted from every dairy producer's milk check to pay for promotion and research through the dairy checkoff.

Dairy Management, Inc. (DMI) is a nonprofit organization co-funded by the National Dairy Board and United Dairy Industry Association.

- DMI conducts programs in integrated marketing, communications, promotion, and research for U.S. dairy farmers.
- DMI manages the National Dairy Council and the American Dairy Association.
- DMI also founded the U.S. Dairy Export Council and the Innovation Center for U.S. Dairy.

There are 16 state and regional dairy checkoff organizations in the United States.

Started in 1937, June Dairy Month was originally called National Milk Month. The American Dairy Association is the national leader for June Dairy Month.

National Grilled Cheese Month is observed in April.

National Ice Cream Month is observed in July.

The mission of National All-Jersey, Inc. is to increase the value of and demand for Jersey milk and to promote equity in milk pricing.

The dairy case is usually placed at the rear of the store because it causes shoppers to walk past many other products to get to the dairy case, which increases impulse buying.

The "Got Milk?" campaign was first used by California milk processors in 1993. It was retired by MilkPEP in 2014 and was replaced by the "Milk Life" tagline.

The Dairy Checkoff's approach to schools switched from "Fuel Up to Play 60" to "Fuel Up" for the 2023-2024 school year.

Dairy Product Consumption

As a person's age increases, his/her milk consumption tends to decrease.

McDonald's is the fast-food chain that uses the most milk in the U.S.

Milk is the victory drink at the Indianapolis 500 each year.

Cheese consumption in the U.S. was at an all-time high at 40.2 pounds per person in 2023.

Dietary Guidelines

The 2025–2030 Dietary Guidelines for Americans recommends choosing full-fat dairy without added sugars when consuming dairy. Three servings of dairy per day are recommended as part of a 2000-calorie dietary pattern.

Organic Dairy Production

USDA's National Organic Program (NOP) regulates the standards for any farm, wild crop harvesting, or handling operation that wants to sell an agricultural product as organically produced. According to the USDA National Organic Program, organic livestock must be:

- Generally managed organically from the last third of gestation.
- Allowed year-round access to the outdoors except under specific conditions like inclement weather.
- Raised on certified organic land meeting all organic crop production standards.
- Raised per animal health and welfare standards.
- Fed 100 percent certified organic feed, except for trace minerals and vitamins used to meet the animal's nutritional requirements.
- Managed without antibiotics, added growth hormones, mammalian or avian byproducts, or other prohibited feed ingredients (e.g., urea, manure, or arsenic compounds).

NOP standards for organic livestock production require access to certified organic pasture throughout the grazing season and a diet consisting of at least 30% dry matter intake from pasture grazed during the grazing season, totaling at least 120 days.

Chapter 10: Dairy Goats

Definitions

Buck – Male goat

Buckling – Male goat that is 6 to 12 months old

Doe – Female goat

Doeling – Female goat the is 6 to 12 months old

Capriculture – The study of goats and goat husbandry

Caprine – Of or pertaining to goats

Kid – Young goat under six months of age

Kidding – Act of giving birth

Wattles – Small appendages, usually hanging from the neck; serve no purpose and are often removed during the first few weeks of life

Wether – Castrated male goat

American Dairy Goat Association

Headquarters – Spindale, NC

Association Manager – Lori Reynolds

The American Dairy Goat Association is third in total dairy animals registered annually in the United States, following the Holstein and Jersey organizations.

The American Dairy Goat Association maintains herdbooks for nine dairy goat breeds:

- Alpine
- Guernsey
- La Mancha
- Nigerian Dwarf
- Nubian
- Oberhasli
- Saanen
- Sable
- Toggenburg

Farmers often select breeds based on productivity (milk and fat percent), efficiency of production, and longevity.

Anatomy

Goats are ruminants and have a four-compartment stomach consisting of the rumen, reticulum, omasum, and abomasum. The rumen makes up about 80% of the mature goat's stomach and has a 4-to-5-gallon capacity.

A doe's udder has two halves, each with a single mammary gland. The doe has two teats.

Normal Stats for Dairy Goats

Temperature – 101.5 to 103.5°F

Pulse rate – 70 to 80 beats per minute

Respiration rate – 12 to 15 breaths per minute

Gestation length – 150 days (145 to 156 days)

Goat's Milk

The normal composition of goat's milk is:

- Fat – 3.8%
- Protein – 3.5%
- Lactose – 4.1%
- Minerals – 0.8%
- Total solids – 12.2%

Factors affecting milk yield and composition include:

- Breed
- Age
- Body size and weight
- Udder size
- Diet
- Stage of lactation
- Season
- Length of dry period
- Environmental temperature
- Health
- Genetics

Industry Statistics

According to the 2022 U.S. Census of Agriculture, the top five states for number of dairy goats were:

1. Wisconsin
2. California
3. Texas
4. Iowa
5. Pennsylvania

According to FAOSTAT, the top five countries for goat's milk production in 2024 were:

1. India
2. Sudan
3. Pakistan
4. Bangladesh
5. France

Judging Scorecard

The ADGA Unified Scorecard for senior does has the following categories and weights:

- General appearance – 35%
- Dairy strength – 20%
- Body capacity – 10%
- Mammary system – 35%

Chapter 11: Miscellaneous

Abbreviations

AYWG – Agricultural Youth Work Guidelines

CTAP – Current Test Day Analysis Program

DART – Direct Access to Records by Telephone

DCR – Data collection rating

DIM – Days in milk

DRP – Dairy Revenue Protection

ECM – Energy corrected milk

ERPA – Estimated relative producing ability

FCM – Fat corrected milk

HAYWG – Hired Agricultural Youth Work Guidelines

ME – Mature equivalent

RIP – Record in progress

ROPS – Rollover protection structure

SMV – Slow moving vehicle

TQM – Total quality management

Weights And Measures

Table 9. Common weights and measures

Item	Weight (pounds)
Gallon of milk	8.6
Quart of milk	2.15
Bushel of corn	56
Bushel of wheat	60
Bushel of barley	48
Bushel of oats	32
Bushel of soybeans	60
Hundredweight (cwt)	100
Kilogram	2.2

U.S. Dairy Industry in 2024

Number of licensed dairy farms – 24,810

Number of dairy cows* – 9.3 million

Milk per cow per year – 24,178 pounds

Milk production – 225.9 billion pounds

Average herd size – 377 cows

*The number of dairy cows reached its peak in 1945.

2024 State Milk Production Rankings

Total milk production

1. California
2. Wisconsin
3. Texas
4. Idaho
5. New York

Cows per herd

1. Arizona
2. New Mexico
3. Texas
4. Florida
5. Colorado

Number of dairy cows

1. California
2. Wisconsin
3. Idaho
4. Texas
5. New York

Milk produced per person

1. Idaho
2. Wisconsin
3. South Dakota
4. Vermont
5. New Mexico

Milk per cow

1. Michigan
2. Wyoming
3. Texas
4. Colorado
5. New York

2024 State Forage Production Rankings

Corn silage

1. Wisconsin
2. California
3. New York
4. Iowa
5. Minnesota

Alfalfa hay and haylage

1. Idaho
2. Nebraska
3. South Dakota
4. Montana
5. California

DHIA

The standard length of a DHIA record is 305 days.

The meaning of "305-2X-ME" on dairy records is that the lactation record was adjusted to a 305-day lactation, twice a day milking, mature equivalent.

If one sees "3X" in a dairy animal's production records, it means the cow was milked three times a day.

A DHIA record may be terminated if a cow has dried off, aborted or died.

Lactation records in progress can be used in calculation of CDCB Sire Summaries if they have at least one test and are a minimum of 40 days in length.

A Data Collection Rating (DCR) is an indicator of the accuracy of production records and is based on the amount of information included in a production record.

National DHIA and Quality Certification Services offer 20 DHI test plans to participating producers.

Laboratory tests available through DHI include:

- Butterfat percentage
- Solids-not-fat percentage (SNF)
- Somatic cell count (SCC)
- Protein percentage
- Milk urea nitrogen (MUN)
- Johne's disease

Culling

Reasons for culling a dairy cow from the herd include:

- Low production
- Reproduction
- Feet and legs
- Injury
- Mastitis
- Udder
- Disease
- Disposition

Dairy cattle can be sold privately on farm or in auction sales. Types of auction sales are consignment, dispersal, and reduction.

Animal Well-Being

According to the American Veterinary Medical Association, animal welfare is the ethical responsibility of ensuring animal well-being.

Animal well-being is the condition in which animals experience good health, can effectively cope with their environment, and are able to express a diversity of species-typical behaviors.

The National Dairy Animal Well-Being Initiative is a producer-led effort to build consumer trust and confidence in the dairy industry's commitment to animal well-being.

An animal rights activist is a person who believes that an animal's life has the same value as a human's life and has the goal of eliminating all systems that involve the use of animals by humans.

Precision Dairy Farming

Precision dairy farming is the use of technologies to measure physiological, behavioral, and production indicators on individual animals to improve management strategies and farm performance.

Examples of precision dairy farming include:

- Daily milk yield monitoring
- Automatic temperature recording devices
- Milk component monitoring
- Milk conductivity indicators
- Pedometers
- Automatic estrus detection monitors
- Accelerometers
- Daily body weight measurements
- Calving alerts

Types of precision dairy wearables include:

- Ear tags
- Neck collars
- Rumen boluses
- Leg tags
- Tailhead tags

Benefits of precision dairy farming include:

- Improved animal health and well-being
- Minimized adverse environmental impacts
- Increased efficiency
- Risk analysis and management
- Reduced costs
- More objective (less observer bias and influence)
- Improved product quality

Farm Business Management

The necessary economic inputs for a dairy operation are land, labor, capital, and management.

A cooperative is a firm that is owned by its farmer members, is operated for their benefit, and distributes earnings based on patronage.

Risk protection programs available to dairy farmers include:

- Dairy Margin Coverage
- Dairy Revenue Protection
- Livestock Gross Margin
- Futures contracts

Dairy Margin Coverage payments are calculated based on the margin between the all-milk price and average feed cost.

Farm Bill

Every five years, the U.S. Congress passes a bundle of legislation called the Farm Bill; it sets national policy for agriculture, nutrition, conservation, and forestry.

The Agricultural Improvement Act of 2018 is the most recent version of the Farm Bill.

Labor Management

The federal minimum wage in the U.S. is $7.25 per hour, effective July 24, 2009. Certain states, cities, and counties have set their own minimum wages above the federal level.

Selection tools that a dairy manager can use when hiring a new employee include:

- Application forms
- Reference checks
- Trial periods
- Interviews
- Work tests

The Worker Protection Standard is an Environmental Protection Agency (EPA) program designed to protect the nation's agricultural workers from pesticides.

The Hired Agricultural Youth Work Guidelines (WAYWG) is designed to help farm employees and supervisors of hired youth reduce the injuries of young workers. The document, Agricultural Youth Work Guidelines (AYWG), helps adults assign age- and ability-appropriate tasks to youth.

Photoperiod

Long-day photoperiod, providing 16 to 18 hours of light per day, may stimulate lactating cows to produce 5 pounds more milk per day on average.

Melatonin is the hormone released by the pineal gland in response to shorter day length.

Short-day photoperiod exposes cows to 8 hours of light followed by 16 hours of darkness. Dry cows exposed to a short-day photoperiod produce more milk in the next lactation than similar cows exposed to long day photoperiod or natural light conditions.

National Dairy Farm Program

The National Dairy Farmers Assuring Responsible Management (FARM) Program was created by the National Milk Producers Federation in cooperation with Dairy Management, Inc.

Its purpose is to show customers that the dairy industry is taking the very best care of cows and the environment, producing safe and wholesome milk, and adhering to the highest standards of workforce development.

Standards for the program are revised every three years.

Freestalls

The main reason that dairy cows refuse to use freestalls is improper size.

For most cows, a stall width of 48 inches is sufficient.

The parts of a freestall include:

- Support post
- Neck rail
- Stall surface (bedding, mattress)
- Stall partition
- Brisket board (tube)
- Rear curb

Housing Ventilation

Proper ventilation moves air and provides fresh air. It is important to accomplish the following:

- Remove organisms from the environment
- Lessen dust
- Remove harmful odors
- Remove extra moisture in the winter
- Remove heat in the summer
- Provide a cleaner environment for animals and people
- Allow buildings to last longer

Chapter 12: Reproduction

Abbreviations

AI – Artificial insemination

CIDR – Controlled internal drug release

CL – Corpus luteum

CR – Conception rate

ET – Embryo transfer

FSH – Follicle stimulating hormone

GnRH – Gonadotropin releasing hormone

IVF – In vitro fertilization

LH – Luteinizing hormone

MGA – Melangestrol acetate

MOET – Multiple ovulation and embryo transfer

PGF2α – Prostaglandin F2α

PR – Pregnancy rate

SCR – Sire conception rate

TAI – Timed artificial insemination

UTJ – Utero-tubule junction

VWP – Voluntary waiting period

Definitions

Abortion – Premature expulsion of a fetus

Anestrus – Failure to have an estrous cycle

Anovulation – Situation that exists when cows are not ovulating

Artificial insemination – Process of freezing semen from a bull and thawing it later to fertilize ova

Calving interval – Period from one calving to the next calving, usually measured in months

Capacitation – Physiological changes that occur to sperm membranes which are essential to attainment of fertilization potential

Caruncle – Uterine side of the placental attachment points

Cold shock – Permanent injury to sperm caused by a sudden decrease in semen temperature after thawing

Conception rate – Percent of services (breedings) that result in a pregnancy

Corpus luteum – Temporary gland that forms on the ovary after the ovum is released; also called yellow body

Cotyledon – Placental side of the placental attachment points

Cryptorchidism – Condition when one or both testes fail to descend from the abdomen into the scrotum, often affecting fertility

Days open – Days from calving until conception or successful breeding date

Days to first service – Days from calving until first breeding date

Embryo transfer – Process of removing a fertilized ovum from a donor cow and transferring it to another cow or heifer; Most embryo transfers are conducted on day 7 or 8 after breeding

Endometritis – Inflammation of the uterine lining

Estrus – Period of heat in dairy cattle

Fertilization – Process of joining an ovum and a sperm. It takes place in the oviduct

Freemartin – Sterile heifer born twin to a bull

French straw – Thin cylinder in which frozen semen is preserved

Gestation – Period of pregnancy; it begins at fertilization and ends at birth

Heat detection rate – Number of animals bred divided by the number of animals eligible for breeding, typically each 21-day cycle

Infertility – Describes the animal that is neither normally fertile nor totally sterile

Involution – Process where the uterus returns to normal size after calving

Metritis – Infection of the uterus

Ovulation – Process of releasing an ovum from the follicle on the ovary

Parturition – Act of giving birth (also called calving, freshening)

Pregnancy rate – Percent of cows that become pregnant out of those cows eligible to become pregnant in a period, usually 21 days

Recipient – An animal that received a fertilized ovum from a donor.

Retained placenta – Condition when the fetal membranes remain attached to the maternal caruncles within the uterus for an extended period after calving (greater than 24 hours).

Service rate – Proportion of cows eligible for service in a set period (usually every 21-day period) that are bred

Sire Conception Rate – An evaluation of artificial insemination (AI) service-sire fertility computed by the Council on Dairy Cattle Breeding; calculated for Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, and Milking Shorthorn bulls

Sterility – Describes the animal that cannot reproduce

Superovulation – Process that involves treating a cow with a hormone (FSH) to increase the number of ova produced

Transvaginal aspiration – Use of ultrasonography to view the ovary while removing oocytes through the vagina using a needle; harvested oocytes are matured and fertilized in vitro

Voluntary waiting period – Time period after calving when the dairy producer chooses not to breed a cow; most common VWP is 60 days

Zygote – A fertilized ovum

Cow's Reproductive Tract

The parts of the cow's reproductive tract are:

- Vulva
- Vagina
- Cervix
- Uterus
- Oviduct (2)
- Ovary (2)

The lower segment of the oviduct closest to the uterus is the isthmus. The connection between the uterus and the oviduct's isthmus is the utero-tubule junction. The large funnel-like structure on the open end of the oviduct is the infundibulum.

The broad ligament is the structure that holds the uterus and ovaries in their proper position.

The main functions of the ovary are production of ova and secretion of hormones essential for reproduction.

One hundred percent (100%) of the ova in a mature cow's ovaries were present at birth.

The fertile life of an ovum after its release from the follicle is 6 to 12 hours.

The site of semen deposition in natural service (bull) is in the vagina next to the cervix; in artificial insemination it is normally in the body of the uterus.

The fetus develops in the uterus after the ovum is fertilized.

Under the influence of progesterone, the uterus produces a nourishing substance for the embryo called uterine milk.

The placenta is the structure through which the fetus receives all its nutrients. The placenta is attached to the uterus in dairy cattle by maternal caruncles and fetal cotyledons (placentomes).

A thick mucus plug is formed in the cervix to prevent bacterial or viral access into the uterus.

Female Reproductive Hormones

Gonadotropin Releasing Hormone (GnRH)

- Secreted by the hypothalamus
- Controls the secretion of pituitary hormones (FSH and LH)

Follicle Stimulating Hormone (FSH)

- Secreted by the anterior pituitary gland
- Stimulates growth of follicles

Luteinizing Hormone (LH)

- Secreted by the anterior pituitary gland
- Causes the follicle to rupture and then causes the corpus luteum to replace the follicle
- Increases dramatically in concentration 24 hours prior to ovulation soon after the onset of estrus

Estrogen (E2)

- Produced by the follicle
- Necessary for behavioral estrus and peaks at the onset of standing estrus

Progesterone (P4)

- Produced by the corpus luteum
- Necessary for the maintenance of pregnancy
- Inhibits the release of GnRH from the hypothalamus

Prostaglandin (PGF)

- Produced by the uterus (endometrium)
- Causes destruction or regression of the corpus luteum

Estrous Cycle

The normal range in length of the estrous cycle is 18 to 24 days.

On average, there are 21 days between heat periods in dairy cows.

The phases of the estrous cycle are:

- Follicular (active follicles are present)
- Luteal (corpus luteum is the dominant ovarian structure)

The stages of the estrous cycle are:

- Estrus: heat period
- Metestrus: transition
- Diestrus: corpus luteum present
- Proestrus: prior to estrus

Follicles develop in a wave-like pattern known as the follicular wave. There are five phases of a follicular wave:

- Recruitment
- Selection
- Growth
- Dominance
- Regression

There are normally 2 or 3 follicular waves during an estrous cycle in cattle.

Dominant follicle is the name given to the largest follicle present on one of the ovaries.

Estrus

Duration of standing heat is usually 2 to 12 hours with an average of 7 hours.

Pregnancy is the most common cause of a cow not coming back into heat. It is estimated that 3 to 5% of pregnant cows exhibit estrus.

Milk progesterone levels are low during estrus.

Signs of estrus in dairy cattle include:

- Restlessness
- Bellowing
- Following and smelling another cow
- Mounting other cows
- Standing to be mounted
- Clear mucus discharge from vulva
- Vulva becomes red and swollen

Standing to be mounted is the most reliable sign of estrus.

A silent heat is the condition where the physical signs of heat are difficult to detect.

Estrus synchronization programs include:

- CIDR
- Ovsynch
- Pre-Synch
- Co-Synch
- Heat-synch

Heat detection aids used on dairy farms include:

- Heat expectancy charts
- Tail chalk
- Pedometers
- Accelerometers
- Pressure sensors
- Electronic heat detection systems
- Detector animals

Artificial Insemination

Sales of dairy semen in the U.S. peaked in 2015 at 24 million doses.

In 2024, 61% of the 16.18 million units of semen purchased by dairy farmers in the U.S. was sexed semen.

Advantages of using artificial insemination over natural service include:

- Safety
- Genetic improvement
- Better disease control
- Better record keeping
- Easier to prove bulls
- Less expensive than keeping a bull
- Greater diversity of sires

A cow should be artificially inseminated 5 to 15 hours after the onset of standing heat.

The most popular semen package available today is the 0.5-ml French straw.

Liquid nitrogen is used to freeze and store semen. The temperature of liquid nitrogen is -320°F.

Frozen semen should be thawed in a warm water bath (90 to 95°F) for a minimum of 40 seconds to maximize the number of motile sperm.

Simple semen tank management practices to maintain semen quality include:

- Avoid excessive movement or abuse of the tank
- Routinely monitor nitrogen levels
- Store in an area with good lighting but out of direct sunlight
- Keep the tank elevated above the concrete floor or other wet and poorly ventilated surfaces
- Store only the amount of semen needed for six months

Ways to eliminate the chance of semen cold shock include:

- Warm the inseminating rod and sheath to body temperature
- Handle the thawed semen and prepare the insemination rod in a warm environment
- Wrap the assembled insemination rod in a clean, dry paper towel and tucking it into some clothing for transport to the cow
- In cold weather use an insulated A.I. gun warmer to transport the loaded A.I. gun to the cow
- Inseminate the cow as soon as possible after the semen has been thawed

Ultrasound

Ultrasound can be used in a reproductive management program in several ways including:

- Pregnancy determination
- Determine embryonic losses
- Determine if twins are being carried
- Monitor cystic ovaries
- Determine sex of embryo

Conception Rate

Factors affecting a dairy herd's conception rate include:

- Heat detection accuracy
- Herd (cow) fertility
- Semen (bull) fertility
- Technician competency
- Environment – heat stress

Reasons cows don't become pregnant when the herd is bred by artificial insemination include:

- Failure to ovulate
- Fertilization failure
- Hormone imbalance
- Poor quality semen
- Failure to inseminate in a timely manner
- Improper insemination technique
- Heat detection errors
- Dirty or broken equipment

Pregnancy Rate

Pregnancy rate is the combined effect of heat detection rate and conception rate.

Pregnancy rate is usually calculated every 21 days because that is the average length of the dairy cow's estrous cycle.

Pregnancy rate can be calculated for AI bred herds, bull bred herds, or a combination of both.

Gestation

Average gestation length varies from 276 to 292 days.

Gestation length can vary due to many factors including:

- Age of the cow
- Breed of the cow
- Breed of the sire
- Sex of the calf
- Number of calves carried
- Season of the year

Brown Swiss cattle have the longest gestation period.

Parturition

Hormonal changes near the time of calving cause the following things to happen:

- Regression of the CL
- Pelvic ligament dilation
- Cervical secretions
- Muscle contractions

Cortisol is the hormone the calf triggers in response to stress to initiate parturition.

Relaxin is the hormone released prior to calving that enables the cervix to soften and stretch in preparation for expelling the calf.

Signs that a cow is near calving include:

- Udder full
- Vulva enlarged
- Mucus discharge
- Restlessness
- Relaxation of ligaments at tail head
- Seeks privacy, separation from herdmates

The three stages of the calving process are:

1. Dilation
2. Expulsion of the calf (labor)
3. Expulsion of the placenta

The normal birth position of a calf is front feet first with the head between the legs. In a breech calving, the rump and tail are presented first.

Intervention with calving is needed only under these conditions:

- Lack of noticeable progress every 15 to 20 minutes
- If the cow or calf are showing significant signs of distress
- If the calf is in an abnormal position

Calving Interval

A herd's average calving interval is influenced by several factors including:

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

Male Reproductive System

The main functions of the testes are to produce sperm and produce the male sex hormones.

Mature sperm are stored in the epididymis.

Sperm live 24 to 30 hours after being deposited in the cow's reproductive tract. It takes sperm 6 hours to become capacitated (i.e., to develop the ability to fertilize the ovum).

Sperm produce lactic acid during metabolism.

Fructose is the primary sugar found in semen.

Male Reproductive Hormones

Follicle stimulating hormone (FSH) stimulates sperm production.

Luteinizing hormone (LH) stimulates sperm production.

Testosterone is responsible for the male sex drive (libido).

Reproductive Health

Reproductive failure is the number one reason for culling in U.S. dairy herds.

It usually takes 30 to 45 days after calving for a cow's reproductive tract to return to normal.

Incidence of metritis, endometritis, and retained placenta is highest in summer.

Poor nutrition and uterine infections are the leading causes of anestrus.

Diseases that cause abortions in dairy cattle include:

- Bovine viral diarrhea (BVD)
- Brucellosis
- Campylobacteriosis (Vibriosis)
- Chlamydia
- IBR
- Leptospirosis
- Listeriosis
- Neosporosis
- Salmonellosis
- Trichomoniasis

Noninfectious causes of abortion include:

- Congenital defects
- Toxins
- Nutritional abnormalities
- Hormonal fluctuations
- Fetal stress

Cystic ovaries are found in 12-14% of problem breeders. They develop in 10-40% of dairy cows during their lifetime.

Types of cystic ovaries are follicular cysts, luteal cysts, and cystic corpus lutea.

Follicular cysts are thin walled, anovulatory (not ovulating) cysts. They secrete variable amounts of estrogen.

Luteal cysts are thick-walled cysts. They secrete low levels of progesterone.

Cystic corpus lutea have characteristics like normal corpora lutea.

Twinning in dairy cattle has several disadvantages including:

- Reduced milk production
- Calving difficulties are more frequent
- Abortion rates are higher
- Twins are often weak at birth
- Potential for a freemartin heifer
- Retained placenta

Ninety percent (90%) of heifers born twin to a bull are sterile.

Chapter 13: Genetics

Abbreviations

AGIL – Animal Genetics and Improvement Laboratory

AIP – Animal Improvement Program

BAA – Breed Age Average

BLAD – Bovine Leukocyte Adhesion Deficiency

BLUP – Best Linear Unbiased Predictor

BWC – Body Weight Composite

CCR – Cow Conception Rate

CD – Cholesterol Deficiency

CE – Calving Ease

CM$ – Cheese Merit

CVM – Complex Vertebral Malformation

DBH – Difficult Birth in Heifers

DCE – Daughter Calving Ease

DNA – Deoxyribonucleic Acid

DOM – Dam of Merit

DPR – Daughter Pregnancy Rate

DSB – Daughter Stillbirth

DUMPS – Deficiency of Monophosphate Synthase

EBV – Estimated Breeding Value

EFC – Early First Calving

ETA – Estimated Transmitting Ability

FLC – Feet and Legs Composite

FM$ – Fluid Merit

FTI – Functional Trait Index

FUI – Functional Udder Index

GL – Gestation Length

GM$ – Grazing Merit

GMD – Gold Medal Dam

GMO – Genetically Modified Organism

gPTA – Genomic Predicted Transmitting Ability

HCR – Heifer Conception Rate

HLIV – Heifer Livability

ICAR – International Committee for Animal Recording

JPI – Jersey Performance Index

LIV – Cow Livability

MACE – Multiple-Trait Across Country Evaluations

mRNA – Messenger Ribonucleic Acid

MSPD – Milking Speed

NM$ – Lifetime Net Merit

PA – Parent Average

PCR – Polymerase Chain Reaction

PJA – Percent Jersey Ancestry

PL – Productive Life

PPR – Progressive Performance Rating

PTA – Predicted Transmitting Ability

PTI – Production-Type Index

RFI – Residual Feed Intake

RFID – Radio Frequency Identification

RNA – Ribonucleic Acid

rRNA – Ribosomal Ribonucleic Acid

RT – Recessive Tested

RVC – Rectovaginal Constriction

SCE – Service Sire Calving Ease

SDM – Spinal Dysmyelination

SMA – Spinal Muscular Atrophy

SNP – Single Nucleotide Polymorphism

SSB – Sire Stillbirth

STA – Standardized Transmitting Ability

TPI – Total Performance Index

tRNA – Transfer Ribonucleic Acid

UDC – Udder Composite

Definitions

Allele – Any of the alternative forms of a gene that may occur at a given locus

Beef-on-dairy – Mating of beef bulls to dairy females, with the resulting offspring used for meat purposes

Chromosome – A threadlike linear strand of DNA and associated proteins found in the nucleus of animal and plant cells that carries the genes and functions in the transmission of hereditary information

Epigenetics – The study of changes in organisms caused by modification of gene expression rather than alteration of the genetic code itself

Gene – The basic unit of inheritance

Gene mapping – The process of determining where genes are located on individual chromosomes

Genome – The total genetic content of an organism

Genomics – The study of genes or gene products in an organism

Genotype – Genetic make-up of an individual

Heritability – Measure of the percent of phenotypic differences between animals for a single trait that can be transmitted to offspring

Locus – Position that a given gene occupies on a chromosome

Pedigree – A record of ancestry

Phenotype – The observed trait of an individual resulting from the effects of the genotype, the environment, and their interaction

Predicted Transmitting Ability – Measurement of average superiority or inferiority that will be transmitted to an offspring

Purebred – A dairy animal whose sire and dam of the same breed are registered or who are eligible to be registered in a herdbook

Reliability – Indicator of the accuracy of genetic evaluations

Siblings – Technical term used to describe brothers and sisters

Basic Genetics

The sire determines the sex of a calf.

Dairy cattle have 30 pairs of chromosomes.

Each dairy animal has about 6 billion DNA base pairs.

The genetic makeup of a population can be changed by migration, selection, mutation, and chance.

Animal Identification

Identification is the first step in a herd improvement program.

A registration paper or certificate accompanies a purebred animal and certifies its parentage.

American ID numbers for dairy cattle consist of a three-letter country code followed by a twelve-digit animal number and will be used by DHI organizations, breed associations, and state animal health departments. The country code for the U.S. is 840.

Visibility is the most important feature when selecting tags or brands for identification.

Animal Model

The Animal Model is the genetic method for evaluating bulls and cows currently used.

When making its evaluation, the Animal Model uses information from:

- Parents (pedigree)
- Individual performance
- Progeny (offspring)

NAAB Code for Sires

The NAAB code for a sire has three parts.

- The number before the letter indicates the stud from which the bull's semen can be purchased. It is referred to as the stud code.
- The letters indicate the breed.
- The number following the letters is an individual bull identification number.

Example: 7HO00543 is the NAAB Code for CARLIN-M IVANHOE BELL.

Table 10. NAAB Stud Code Examples

Bull Stud	Stud Code
Genex Cooperative	1
Select Sires Inc.	7
Alta Genetics USA Inc.	11
ABS Global	29
Semex Alliance	200
ST Genetics	551

Table 11. NAAB Breed Abbreviations

Breed	Abbreviation
Ayrshire	AY
Brown Swiss	BS
Guernsey	GU
Holstein	HO
Jersey	JE
Milking Shorthorn	MS
Red and White	WW

Genetic Evaluations

The Council on Dairy Cattle Breeding publishes U.S. genetic evaluations.

Official evaluations are released in April, August, and December. Genomic evaluations are released monthly.

A minimum of ten (10) daughters is required for a bull to have a bull proof published.

The genetic base for genetic evaluations is updated every five years. It was updated in April 2025 and is the average PTA of animals born in 2020. The next base change is scheduled for 2030.

INTERBULL is the name of the International Bull Evaluation Service based in Uppsala, Sweden.

Genetic Indexes

Lifetime Net Merit (NM$) is a genetic index which includes the following traits:

- Milk
- Fat
- Protein
- Somatic Cell Score
- Productive Life
- Foot and Leg Composite
- Udder Composite
- Body Weight Composite
- Daughter Pregnancy Rate
- Heifer Conception Rate
- Cow Conception Rate
- Calving Ability
- Livability
- Health
- Residual Feed Intake
- Early First Calving
- Heifer Livability

The Health Trait Index includes the following traits:

- Milk fever
- Displaced abomasum
- Ketosis
- Mastitis
- Metritis
- Retained placenta

Total Performance Index (TPI) is a genetic index used by the Holstein breed that is determined by placing emphasis on production and type. The traits included are:

- Protein
- Fat
- Feed Efficiency
- Type
- Udder Composite
- Feet and Leg Composite
- Productive Life
- Health Trait Index
- Cow Livability
- Somatic Cell Score
- Fertility Index
- Daughter Calving Ease
- Daughter Stillbirth

Traits used in the Udder Composite Index for Holsteins are:

- Udder depth
- Fore udder attachment
- Udder cleft
- Rear udder height
- Rear udder width
- Front teat placement
- Rear teat placement
- Teat length
- Stature

Traits used in the Body Weight Composite Index for Holsteins are:

- Stature
- Body Depth
- Strength
- Rump Width
- Dairy Form

The Feet and Legs Composite Index for Holsteins is calculated using the traits of:

- Foot Angle
- Rear Legs – Side View
- Rear Legs – Rear View
- Feet and Legs Score
- Stature

Traits used in the Dairy Capacity Composite Index for Holsteins are:

- Dairy Form
- Strength

The Jersey Performance Index (JPI) is a genetic index used by the Jersey breed that is determined by placing emphasis on production and type. Traits in the 2023 JPI are:

- Protein
- Fat
- Daughter Pregnancy Rate
- Cow Conception Rate
- Productive Life
- Somatic Cell Score
- Mastitis
- Udder Depth
- Fore Udder
- Rear Udder Height

The Jersey Udder Index serves as an indicator of mastitis resistance in Jerseys; it uses the following traits:

- Udder Depth
- Fore Udder Attachment
- Udder Cleft
- Rear Udder Height
- Teat Placement
- Teat Length
- Rear Udder Width
- Rear Teats – Side View
- Rear Teats – Rear View

Calving Ease

Farm employees should assign calving ease scores at the time of calving to describe the event. The scoring system is:

- 1 = No problem or unobserved
- 2 = Slight problem
- 3 = Needed assistance
- 4 = Considerable force
- 5 = Extremely difficult

The Council on Dairy Cattle Breeding calculates two Calving Ease Summaries for the National Association of Animal Breeders (NAAB):

- Service Sire Calving Ease measures a bull's tendency to sire calves that are born easily.
- Daughter Calving Ease measures the influence of the sire of the cow on calving ease.

Stillbirth

It is recommended that farm employees record stillbirth scores to provide accurate calf mortality information. The scoring system is:

- 1 = the calf was born alive and was alive 48 hours postpartum
- 2 = the calf was born dead
- 3 = the calf was born alive but died within 48 hours postpartum

Daughter Stillbirth measures the ability of a particular cow (daughter) to produce live calves.

Service Sire Stillbirth measures the tendency of calves from a particular service sire to be stillborn.

Stillbirth evaluations are expressed as percent stillbirths in heifers (%SBH), where stillborn calves are those scored as dead at birth or born alive but died within 48 hours of birth.

Inbreeding

Inbreeding can decrease mature equivalent (ME) milk production by 60 to 80 pounds per lactation for each percent increase in inbreeding.

Consequences of inbreeding include:

- Decreased general vigor
- Decreased production
- Decreased reproductive performance
- Increased calf mortality
- Increased similarity between animals
- Smaller mature size
- More recessive genes exposed
- Slower growth rate
- Lower immunity

Undesirable Recessive Traits

Undesirable recessive traits found in Ayrshires are:

- Fish Milk
- Curly Calves (Arthrogryposis multiplex)

Undesirable recessive traits in Brown Swiss cattle are:

- Weaver
- Spiderleg
- Spinal Dysmyelination
- Spinal Muscular Atrophy

Undesirable recessive traits in Guernseys include:

- Complex Vertebral Malformation
- Haplotype Cholesterol Deficiency

Undesirable recessive traits in Holsteins include:

- BLAD
- Brachyspina
- Bulldog
- Cholesterol Deficiency
- Complex Vertebral Malformations
- DUMPS
- Early onset muscle weakness
- Mule-Foot (Syndactylism)

Undesirable recessive traits found in Jerseys are:

- Jersey Neuropathy with Splayed Forelimbs (JNS)
- Limber Legs
- Rectovaginal Constriction

Undesirable recessive traits have not been documented for Guernseys or Milking Shorthorns.

Chapter 14: Animal Health

Abbreviations

BLV – Bovine Leukosis Virus

BRD – Bovine Respiratory Disease

BRSV – Bovine Respiratory Syncytial Virus

BSE – Bovine Spongiform Encephalopathy

BVD – Bovine Virus Diarrhea

CVI – Certificate of Veterinary Inspection

DA – Displaced Abomasum

ELISA – Enzyme-Linked Immunosorbent Assay

FARAD – Food Animal Residue Avoidance Databank

FMD – Foot and Mouth Disease

HBS – Hemorrhagic Bowel Syndrome

HPAI – Highly Pathogenic Avian Influenza

IBR – Infectious Bovine Rhinotracheitis

Ig – Immunoglobulin

IM – Intramuscular

IV – Intravenous

MLV – Modified Live Virus

NAHMS – National Animal Health Monitoring System

NSAID – Non-Steroidal Anti-Inflammatory Drug

PCR – Polymerase chain reaction

PPE – Personal Protective Equipment

SMS – Secure Milk Supply (Plan)

VFD – Veterinary Feed Directive

Definitions

Antibiotics – Chemical agents given to animals that kill or stop the growth of bacteria

Antibodies (Immunoglobulins) – Proteins synthesized by organs of the cow's immune system that aid in the elimination of foreign substances such as microorganisms; the main immunoglobulin isotypes are IgA, IgE, IgG, and IgM

Balling gun – Instrument used to give an animal a pill

Biocontainment – Part of biosecurity that focuses on keeping diseases from spreading to other farms

Bioseclusion – Part of biosecurity that focuses on the prevention of disease introduction on farms

Biosecurity – Management practices that protect the herd from the entry of new diseases and minimize the spread and/or adverse effects of diseases in the herd

Carrier – An animal that is infected with a disease but has no clinical symptoms

Disease – A change in the normal state of the body, or one or more of its organs, which disturbs the proper performance of body functions

Enzyme – Protein that acts as a catalyst in starting or speeding up specific chemical reactions

Erythrocytes – Red blood cells; only cells that have no nucleus

Morbidity rate – Number of sick animals during a specified period

Mortality rate – Number of dead animals during a specified period

Pathogen – Any microorganism that causes disease

Phagocytosis – Process by which white blood cells engulf microorganisms

Physiology – Branch of biology that deals with the process, activities, and phenomena of life and living organisms

Toxin – Poison produced by microorganisms that kills cells

Trocar – An instrument used to puncture the rumen in cases of bloat

Zoonoses – Diseases and infections that are transmitted between vertebrate animals and human beings

Proper and Common Disease Names

The proper name of each disease is listed first followed by its common name.

- Acetonemia – Ketosis
- Bovine spongiform encephalopathy – Mad cow disease
- Brucellosis – Bang's disease
- Displaced abomasum – Twisted stomach
- Dystocia – Calving difficulty
- Hemorrhagic bowel syndrome – Bloody gut
- Hypocalcemia – Milk fever
- Infectious bovine keratoconjunctivitis – Pinkeye
- Infectious bovine rhinotracheitis – Red nose
- Laminitis – Founder
- Listeriosis – Circling disease
- Papillomatosis – Warts
- Papillomatous digital dermatitis – Hairy heel warts
- Paratuberculosis – Johne's disease
- Parturient paresis – Milk fever
- Pneumonic pasteurellosis – Shipping fever
- Pododermatitis – Foot rot
- Traumatic gastritis – Hardware disease

Normal Stats for Dairy Animals

- Temperature (Calf) = 102.5°F
- Temperature (Adult dairy cow) = 101.5°F
- Pulse rate (cow) = 60 - 70 heart beats per minute
- Respiratory rate (cow) = 30 breaths per minute

Anatomy And Physiology

The basic tissues that make up a cow's body are:

- Connective
- Epithelium
- Muscle
- Nerve

The organ systems found in the body are:

- Circulatory
- Digestive
- Endocrine
- Integumentary (skin)
- Muscular
- Nervous
- Reproductive
- Respiratory
- Skeletal

Insulin is a hormone produced by the pancreas that promotes cell growth and division.

The parathyroid gland is responsible for mobilizing calcium from the bone.

Ligaments connect one bone to another bone; tendons connect muscle to a bone.

The mitochondrion is known as the powerhouse of the cell because all energy is produced in this cell part.

Approximately 400 pounds of blood are pumped through the udder to produce one pound of milk. The external pudic artery is the major artery supplying blood to the udder.

Diseases

Diseases can be classified based on their primary cause:

- Environmental
- Genetic
- Infectious
- Metabolic

Diseases may be transmitted in many ways including:

- Aerosol
- Direct contact
- Fomite
- Oral
- Reproductive
- Traffic
- Vector-borne
- Zoonotic

Infectious diseases of cattle result from the interplay between three factors:

- The animal and its ability to resist disease (immunity)
- An infectious agent (bacteria, viruses, and parasites)
- The environment

Diseases in dairy cattle that are caused by a virus include:

- Blue tongue
- BLV
- BRSV
- BVD
- Cow pox
- IBR
- PI-3
- Warts

Diseases caused by clostridial organisms include:

- Blackleg
- Malignant edema
- Overeating disease
- Tetanus

Examples of metabolic diseases are:

- Displaced abomasum
- Ketosis
- Laminitis
- Milk fever
- Retained placenta

Diseases with a color in their name include:

- Blackleg
- Blue tongue
- Pinkeye
- Red nose
- Red water
- White heifer disease
- White muscle disease

Zoonoses that may be transmitted from cattle to humans include:

- Brucellosis
- Cowpox
- Cryptospirosis
- Leptospirosis
- Listeriosis
- Q-fever
- Rabies
- Ringworm
- Salmonellosis
- Tuberculosis

Acidosis

Acidosis is a metabolic disorder that often occurs when a dairy cow eats too much grain.

Blackleg

Blackleg is an acute, fever producing disease of cattle and sheep.

The bacterium Clostridium chauvoei causes the disease.

Blackleg most often occurs in pastured cattle during the spring or fall.

Bloat

Bloat is the condition when a cow cannot belch.

Cows grazing rapidly growing legumes are susceptible to bloat.

Gases associated with bloat are carbon dioxide and methane.

Poloxolene may be administered to prevent or correct bloat.

Simple laundry detergent can be used to alleviate bloat in cattle.

Bovine Leukosis Virus

Bovine Leukosis Virus (BLV) is a retrovirus that infects lymphoid tissue.

The virus is transmitted to cattle mainly by direct exposure with infected blood, saliva, semen, and milk.

Signs of BLV infection include:

- Tumors in lymphoid tissues
- Enlarged lymph nodes
- Weight loss
- Decreased milk production
- Fever
- Loss of appetite
- Rear limb weakness or paralysis
- Protruding eyeballs
- Gastrointestinal obstructions
- Increased blood lymphocyte counts

Brucellosis

Brucellosis (Bang's disease) is caused by a bacterium. Infections may cause:

- Abortions
- Stillborn or weak calves
- Retained placentas
- Weight loss
- Reduced milk yield

The milk ring test is used to identify Brucellosis in cattle.

Undulant fever is the human equivalent of brucellosis. Drinking raw milk contaminated with Brucella bacteria is the means of contracting the disease.

Coccidiosis

Coccidiosis is a disease in calves that is also very common in poultry and is characterized by chronic diarrhea. Signs of coccidia in calves include:

- Watery scours with flakes of blood
- Dull listlessness
- Mucus in the feces
- Dehydration
- Weight loss

Methods to control coccidiosis include:

- Accurate diagnosis and monitoring
- Maintain sanitation
- Limit stress
- Medicate

There are two classes of anti-coccidial drugs:

- Coccidiocides kill coccidia as they migrate through the intestine, interrupting the organism's life cycle.
- Coccidiostats inhibit the coccidia's growth and development, preventing them from reproducing.

Cryptospirosis

Cryptosporidium parvum is a protozoan parasite that has been recognized as a common cause of diarrhea in calves and other animals, including humans.

Management practices that can reduce cryptospirosis in newborns include:

- Provide clean, dry areas for cows to calve
- Feed colostrum using a clean bottle and sanitized nipple
- Provide clean, dry pens for calves
- Allow pens to thoroughly dry between calves
- Feed and care for sick calves last

Displaced Abomasum

A displaced abomasum is the condition where the abomasum moves positions inside the body cavity and twists, causing severe digestive problems.

Most displaced abomasums are left-sided (80-90%).

Predisposing factors for a cow's displaced abomasum include:

- Acidotic rations
- Advanced pregnancy
- High milk production
- Hypocalcemia
- Lack of exercise
- Lead feeding
- Selenium deficiency
- Stress of calving

Fat Cow Syndrome

Fat cow syndrome is a disease when a cow gains too much weight during late lactation or the dry period.

The disease is almost always associated with other problems at calving including:

- Displaced abomasum
- Fatty liver syndrome
- Mastitis
- Metritis
- Milk fever
- Retained placenta

Grass Tetany

Grass tetany is a metabolic disorder associated with a magnesium deficiency.

The disorder occurs most often in adult cows milking heavily and grazing lush green pastures.

Hardware Disease

Hardware disease is a general term used to describe a situation where a piece of metal has been swallowed and then collects in and/or pierces the reticulum.

A magnet is often given to an animal to prevent hardware disease.

Heat Stress

The ideal environmental temperature range for dairy cattle is 25 to 65°F.

A dairy cow can lose body heat through convection, conduction, radiation, and evaporation.

Methods used to cool cows during heat stress include:

- Shade
- Air exchange
- Air movement
- Access to water
- Sprinkle

Johne's Disease

Johne's disease is caused by the bacterium Mycobacterium paratuberculosis, which infects the small intestine of ruminant animals, especially cattle, sheep, and goats.

Cattle with Johne's disease are usually infected soon after birth, but the first symptoms do not appear until 2 to 4 years of age.

Clinical symptoms of Johne's disease include:

- Diarrhea
- General unthriftiness
- Soft swelling in the jaw
- Substantial drops in milk production
- Weight loss
- Susceptibility to other problems such as infertility
- Death

Types of tests for Johne's disease commonly used today are:

- Tests that measure antibodies in blood serum
- Tests that find the organism in manure by fecal culture or polymerase chain reaction (PCR)

No effective treatment can be recommended for Johne's disease. Therefore, producers must concentrate on preventing new infections.

Strategies for preventing new Johne's disease infections include:

- Prevent highly susceptible newborn calves and young animals from ingesting manure from adults, whether from the dam, the environment, or feed and water.
- Calving areas should be dry, free of manure, and well-bedded.
- Remove the calf from the dam immediately after birth.
- Do not use the same equipment to clean up manure and to load feed.
- Do not walk in feed bunks.
- Identify and remove infected animals and their manure.
- Investigate all animals considered for purchase and buy only from test-negative herds with no history of Johne's disease.
- Do not allow test-positive cows to calve.
- Sell at birth all calves from positive cows.

Ketosis

Ketosis (acetonemia) is a condition when there is an accumulation of ketones in the body.

Highest incidence of subclinical ketosis occurs within the first seven (7) days after calving.

Key risk factors for developing ketosis include:

- Obese cows during the dry period and at calving
- High milk production

The first signs of ketosis are:

- Cow goes off feed
- Ketone (acetone) smell on the cow's breath

Propylene glycol is fed or administered to cows to treat ketosis.

Niacin may be added to feeds to aid in the prevention of ketosis.

Lameness

A cow may experience lameness for many reasons including:

- Abscess
- Foot rot
- Infection
- Injury
- Soft sole syndrome
- Trimming too close

Factors contributing to the cost of lameness include:

- Treatment costs
- Nonsalable milk
- Reduced milk production
- Reduced reproductive performance
- Increased risk of death and culling
- Lameness recurrence
- Elevated incidence of other disease
- Prevention costs

The most important practices for the reduction of foot problems are hoof trimming and footbaths.

The purposes of a footbath are:

- Remove irritants from the foot and between the toes
- Disinfect and cleanse the foot
- Dry and toughen the foot

Substances commonly used in a footbath include copper sulfate, zinc sulfate, and formalin.

The most common walk-through treatment for foot rot is a 5% solution of copper sulfate.

Mad Cow Disease

Mad Cow Disease (Bovine Spongiform Encephalopathy) is a fatal brain disease of cattle; it affects the brain and spinal cord.

The disease originated in the United Kingdom.

Milk Fever

Milk fever is caused by a deficiency of blood calcium related to an imbalance of calcium, phosphorus, and Vitamin D.

Most cases of milk fever occur within 72 hours after calving.

About 6 percent of dairy cows are affected by milk fever each year.

Groups of cows that are at greater risk of having milk fever are older cows, fatty liver cows, and Jerseys.

Symptoms of milk fever include:

- Cow goes down
- Rapid heart rate
- Dilated eyes
- Below normal body temperature

Calcium glutamate is an intravenous injection for immediate and temporary treatment of milk fever.

Mycotoxins

A mycotoxin is a toxin produced by a fungus, especially a mold.

Members of the mycotoxin family that affect animals include:

- Aflatoxin
- Trichothecenes
- Zearalenone
- Fumonisin
- Ochratoxins
- Ergot alkaloid

Clinical symptoms of mycotoxins in dairy cattle include:

- Abortions
- Cystic ovaries
- Feed refusal
- Gastrointestinal upsets
- Infertility
- No milk
- Poor response to therapy
- Silent heats
- Unthriftiness
- Weight loss
- Rise in metabolic disease due to liver malfunction

Neosporosis

Neosporosis is a disease that causes abortions and occasionally causes birth of weak “dummy” calves that have serious brain infections.

A protozoan, Neospora caninum, causes the disease. Dogs are classified as a definitive host for the causative organism.

Parasites

Internal parasites in dairy cattle include:

- Lung worms
- Roundworms
- Stomach worms
- Liver flukes
- Coccidia

The brown stomach worm is the most economically detrimental parasite of cattle.

Anthelminthics are a class of chemicals used to kill internal parasites.

External parasites in dairy cattle include flies, lice, mites, mosquitoes, and ticks.

Lice are most troublesome during winter and spring.

Types of flies commonly found around the dairy farm are:

- House fly
- Stable fly
- Face fly
- Horn fly
- Heel fly
- Deer fly

The face fly spreads pinkeye.

The heel fly is associated with grubs or warbles in cattle.

House and stable flies need heat, moisture, and a suitable breeding medium to survive and reproduce.

The phases of a fly's life cycle are:

1. Egg
2. Larvae
3. Pupa
4. Adult

Sanitation is the most effective management tool to control flies on a dairy farm.

Pinkeye

Pinkeye is a highly contagious disease characterized by an infection of the cornea or membrane lining of the eye; it is most prevalent during the summer. The primary infectious agent is Moraxella Bovis, a bacterium.

Measures for preventing pinkeye include:

- Fly control
- Vaccination
- Clipping pastures to prevent seed-head development

Pneumonia

Pneumonia is a disease characterized by an inflammation of the lunhs.

Predisposing causes of pneumonia in calves include:

- Poor ventilation
- High humidity
- Dirty pens
- Poor nutrition
- Overcrowding
- Wide range of ages in one pen
- Drastic temperature changes

Types of organisms that can cause pneumonia are:

- Bacteria
- Molds
- Parasites
- Viruses
- Yeasts

Pneumonia-causing bacteria include:

- Pasteurella multocida
- Mannheimia (Pasteurella) haemolytica
- Haemophilus somnus
- Mycoplasma species

Pneumonia-causing viruses include:

- Infectious bovine rhinotracheitis virus (IBR)
- Parainfluenza-3 virus (PI3)
- Bovine viral diarrhea virus (BVDV)
- Bovine respiratory syncytial virus (BRSV)

Rabies

Rabies is a deadly viral infection that is mainly spread by infected animals.

Suspected cases of rabies are confirmed by:

- Fluorescent antibody test of brain
- By injecting brain tissue into mice and observing

Non-domestic animals that can cause an infection of cattle with rabies include:

- Bat
- Bobcat
- Coyote
- Fox
- Raccoon
- Skunk

Ringworm

Ringworm is a contagious disease caused by a fungus that can be easily spread to other animals. The fungus infection invades the hair follicles and the outer layer of skin.

Tincture of iodine may be used to control ringworm.

Scours

Scours is a disease in calves characterized by diarrhea, dehydration, and unthriftiness. It is easily transferred from one animal to another through the manure of an infected animal.

Bacteria that commonly cause scours among calves include Escherichia coli, Salmonella, and Clostridium perfringens.

Viruses that commonly cause scours among calves include Rotavirus and Coronavirus.

Protozoa that commonly cause scours among calves include coccidia and Cryptosporidium.

Shipping Fever

Shipping fever is a respiratory disease that cattle often develop after being transported by truck or rail.

Udder Edema

Udder edema is a condition that exists when an excessive amount of lymph accumulates between the skin and secretory tissue of the udder.

Warts

Warts are caused by a virus and are contagious to other calves.

White Muscle Disease

White muscle disease is caused by a deficiency of Vitamin E and/or selenium.

The best way to prevent the disease is to supplement Vitamin E and selenium.

Antibiotics

Antibiotics are only effective to treat bacterial infections.

A cow may be given antibiotics in numerous ways including:

- Intramuscular injection
- Intravenous injection
- Intraperitoneal injection
- Intramammary infusion
- Intrauterine infusion
- In the ration

The jugular vein is the ideal location for most intravenous injections.

In its regulations for antibiotic usage, the Food and Drug Administration defines “lactating cow” as any dairy female over 20 months old.

Vaccinations

Calfhood vaccinations should be considered for the following diseases:

- Blackleg
- Brucellosis
- BVD
- Clostridia
- IBR
- Leptospirosis
- Malignant edema
- PI-3
- Scours

The major types of vaccines are killed and modified live.

Medicine Chest

Suitable items for a medicine chest for the average herd include:

- Alcohol
- General use disinfectant
- Iodine solution
- Bloat remedy
- Teat and udder ointments
- Adhesive tape
- Scissors
- Soap
- Trocar and cannula
- Petroleum jelly
- Sterile bandaging material
- Wash basin
- Syringe and needles

A needle should be used only once before it is disposed.

Chapter 15: Nutrient Management

Abbreviations

BMP – Best management practices

CAFO – Concentrated animal feeding operation

CNMP – Comprehensive nutrient management plan

CWA – Clean Water Act

EQIP – Environmental Quality Incentive Program

IPM – Integrated pest management

NPS – Non-point source

Water

Groundwater is water in the soil. It may resurface in a brook, stream, or pond. Water in drinking water wells is from groundwater.

Surface water is water in any exposed body of water including streams, rivers, ponds, lakes, and oceans.

The leading environmental issues facing farmers are phosphorus (P) and nitrogen (N) contamination of ground and surface water.

Runoff is the movement of nutrients across the surface of soils to surface water (streams, rivers, ponds).

Leaching is the movement of nitrate (a nitrogen containing compound) through soils to groundwater.

Well-managed alternative water sources usually provide animals cleaner water and help prevent exposure to certain diseases.

Manure

Manure storage allows manure to be applied according to crop needs rather than daily.

Types of storage facilities for manure are:

- Solid manure storage (dry stack barn)
- Slurry manure storage (anaerobic pit, earthen structure, or above ground tank)
- Liquid manure storage (lagoon)

Slurry manure storage is the most common type of manure storage on dairy farms.

General categories of odor-controlling chemicals for manure management are:

- Masking agents
- Odor counteractants
- Enzymatic products

Manure testing (measuring nutrient content) may reduce fertilizer purchases and/or prevent application of nutrients that exceed crop requirements.

Factors that affect the nutritive value of manure are:

- Climate
- Crop
- Method of application
- Method of collection
- Method of storage
- Soil characteristics
- Time of application
- Type of feed ration
- Amount of added feed, bedding & water

Non-Point Source Pollution

Non-point source usually refers to pollution (nutrients, chemicals, toxins or pathogens) that contaminate ground or surface water.

Non-point source pollution originates from multiple and diffuse sources which are not readily identified.

Examples of non-point sources of nutrient pollution include most farms, agricultural cropland, and suburban lawns receiving fertilizer.

Best Management Practices

Best management practices are practices that protect water quality while improving profitability of the farm.

The Soil and Water Conservation District (SWCD) is a local board that defines priority watersheds, approves conservation plans, and distributes cost share funds to farmers for implementation of BMPs.

Cost-share is a financial incentive from the state or federal government to the farmer to help pay for equipment or practices that reduce pollution.

Best management practices for livestock farms include:

- Fencing animals out of bodies of surface water
- Installation of an alternative water source
- Installation of stream crossings
- Installation of buffer strips between cropland and surface water
- Shoreline or creek bank stabilization and protection
- Animal travel lane stabilization
- Rotational loafing lot management system
- Installation of a stormwater retention pond
- Planting small grain cover crops
- Installation of a manure storage facility
- Manure testing
- Controlling surface water runoff
- Implementation of a nutrient management plan

Buffer strips are areas of grassland installed between cropland or feedlots and waterways to take up nutrients and prevent nutrients from running off into water.

- Benefits of small grain cover crops include:
- Increase use of land applied nutrients
- Stabilize cropland
- Prevent erosion in wintertime

The rotational loafing lot management system consists of vegetated exercise and rest areas installed to replace dirt exercise lots. Its benefits are:

- Runoff is reduced because grass growing on lots uses nutrients
- Soil erosion is reduced because grass growing on lots stabilizes soil
- Cows stay cleaner

Methods of reducing soil erosion include:

- Contour cropping
- Cover crop
- Grass waterways
- Reduced tillage
- Soil seeding
- Strip cropping
- Terracing
- Wind breaks

Bedding Materials

Common dairy cattle bedding materials include:

- Newspaper
- Recycled manure solids
- Sand
- Sawdust (green or kiln-dried)
- Shavings
- Straw

Advantages of using dried manure solids as bedding include:

- Cost
- Cow comfort
- Environmental sustainability

Nutrient Management

A nutrient management plan is a plan for the land application of manure and fertilizer to meet crop needs.

Animal density impacts nutrient management on farms and is usually measured as animal units per acre. An animal unit is 1000 pounds of live weight of any animal.

Areas that contribute animal waste that must be handled are:

- Feeding area
- Housing or loafing area
- Holding pen area
- Milking parlor
- Runoff area

Waste Management Systems

The following factors should be considered when planning a waste management system:

- Environmental (Rainfall, stream location, prevailing winds, evaporation, temperature, topography, soil type, surface drainage, water table depth)
- Operational (Herd size, cropping & feeding practices, land area, cropland for waste application, existing buildings & machinery)
- Economic (Availability of capital and labor, future expansion plans)
- Social (Neighbors, zoning)
- Legal Requirements (EPA General Permit, State and local permits)

Composting

Composting requires:

- Air
- Moisture
- Nutrients
- Carbon

Composting is an acceptable way of disposing of dead calves and cows. Two to six months are required for composting depending on the size of the animal and the rate of the compost reaction.

Advantages of composting manure include:

- Reduces volume
- Does not attract flies and insects
- Reduces potential for nutrient runoff
- Weeds and pathogens destroyed
- More uniform than manure
- Reduces fertilizer needs
- Excellent soil conditioner

Fertilizer

Fertilizer labels have three important numbers.

The first number is the amount of nitrogen (N).

The second number is the amount of phosphate (P2O5).

The third number is the amount of potash (K2O).

These three numbers represent the primary nutrients: nitrogen (N), phosphorus (P), and potassium (K).

A bag of 15-10-5 fertilizer contains 15 percent nitrogen, 10 percent phosphate, and 5 percent potash.

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