2014 Virginia 4-H Dairy Quiz Bowl Materials

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<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dates in Dairy History</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>People and Organizations</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Dairy Breeds</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Dairy Cattle Judging, Fitting and Showing</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>Calf and Heifer Management</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>Nutrition, Feeds and Feeding</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>Lactation and Milking Management</td>
<td>28</td>
</tr>
<tr>
<td>8</td>
<td>Dairy Products and Milk Marketing</td>
<td>35</td>
</tr>
<tr>
<td>9</td>
<td>Miscellaneous</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>Reproduction</td>
<td>45</td>
</tr>
<tr>
<td>11</td>
<td>Genetics</td>
<td>51</td>
</tr>
<tr>
<td>12</td>
<td>Animal Health</td>
<td>56</td>
</tr>
<tr>
<td>13</td>
<td>Nutrient Management</td>
<td>66</td>
</tr>
<tr>
<td>Appendix</td>
<td>Suggested Reading</td>
<td>69</td>
</tr>
</tbody>
</table>

**Note**

Senior 4-H'ers competing in district and state 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'ers will only be responsible for Chapters 1-9.

**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 editor, so your suggestions may be included in the next revision. Thanks!
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 condensory built by Gail Borden in Burrville, Connecticut
1862 --- Morrill Act enacted to create the Land Grant College System
1868 --- American Jersey Cattle Club founded
1877 --- American Guernsey Cattle Club founded
1878 --- Centrifugal cream separator invented
1880 --- Brown Swiss Breeders Association founded
1884 --- Milk bottle invented
1885 --- *Hoard’s Dairyman* magazine first published
        Holstein-Friesian Association of America formed
1886 --- Automatic bottle filler and capper patented
1887 --- Hatch Act enacted to create 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.
        National Dairy Council organized
1914 --- Smith-Lever Act signed establishing the Cooperative Extension Service
1916 --- National Milk Producers Federation founded
1917 --- *Journal of Dairy Science* first published
1922 --- Capper-Volstead Act passed by Congress to empower farmers and agricultural producers to market, price, and sell their products through cooperative means
1926 --- Dairy Herd Improvement testing program started
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, which provides for federal milk marketing orders, passed
Chapter 1: Dates in Dairy History

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--- The PDCA Dairy Cow Unified Score Card was first copyrighted
1945--- First edition of the National Research Council’s *Nutrient Requirements of Dairy Cattle* was 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 Improvement Association organized
1967--- World Dairy Expo founded and holds first show
1974--- Nutrition labeling of fluid milk products begins
1983--- INTERBULL developed
        Dairy and Tobacco Adjustment Act created National Dairy Promotion and Research Board and a
        15-cent dairy check-off
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
        Federal Milk Marketing Orders reformed to reduce the number of orders
2001--- National Research Council’s *Nutrient Requirements of Dairy Cattle* most recently updated (7th edition)
2002--- North American Intercollegiate Dairy Challenge established
2003--- Sexed semen becomes commercially available
2009--- Most recent revision of the PDCA Dairy Cow Unified Score Card
        Genomic predictions of genetic merit officially released by USDA-AIPL
2011--- PDCA Showmanship Evaluation Card revised
2013--- Council on Dairy Cattle Breeding assumes responsibility for publishing U.S. dairy genetic evaluations
ACRONYMS

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 (USDA)
AOAC .......................................................... American Organization of Analytical Chemists
APHIS .......................................................... Animal and Plant Health Inspection Service (USDA)
ARS ............................................................ Agricultural Research Service (USDA)
CCC .............................................................. Commodity Credit Corporation
CME ............................................................. Chicago Mercantile Exchange
CSS .............................................................. Certified Semen Services
DCHA ............................................................ Dairy Calf and Heifer Association
DCRC ............................................................ Dairy Cattle Reproductive Council
DHIA ............................................................ Dairy Herd Information Association
DHIR ............................................................. Dairy Herd Information Registry
DRPC ............................................................. Dairy Records Processing Center
DRINC .......................................................... Dairy Research, Inc.
EPA .............................................................. Environmental Protection Agency
FASS ........................................................... Federation of Animal Science Societies
FCS ............................................................... Farm Credit Services
FDA ............................................................. Food and Drug Administration
FSA .............................................................. Farm Service Agency (USDA)
FSIS ............................................................. Food Safety Inspection Service (USDA)
IDF ............................................................... International Dairy Federation
IDFA ............................................................. International Dairy Foods Association
IMS ............................................................... Interstate Milk Shippers
NAAB .......................................................... National Association of Animal Breeders
NADC .......................................................... National Animal Disease Center
NAIDC ........................................................ National Animal Disease Information Center
NASS .......................................................... National Agricultural Statistics Service (USDA)
NCIMS ........................................................ National Conference on Interstate Milk Shipments
NDC ............................................................. National Dairy Council
NDHIA ........................................................ National Dairy Herd Information Association
NDPRB ........................................................ National Dairy Promotion and Research Board
NMC ............................................................. National Mastitis Council
Chapter 2: People and Organizations

NMPF.................................................................National Milk Producers Federation
NRC.................................................................National Research Council
NRCS............................................................Natural Resource Conservation Service (USDA)
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
YD LI ..............................................................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. Gustaw Delaval invented the centrifugal cream separator.
W. D. Hoard founded Hoard’s Dairyman, the national dairy farm magazine.
Louis Pasteur invented pasteurization. He is considered the first person to discover that bacteria cause food spoilage and disease.
Dr. Harvey Thatcher invented the milk bottle.

DAIRY INDUSTRY LEADERS

Jim Mulhern .............................................. President and CEO, National Milk Producers Federation
Corey Geiger .............................................. Managing Editor, Hoard’s Dairyman
Jay Mattison ............................................. Chief Executive Officer and Administrator, National DHIA
Dave Natzke ............................................. Editor, Dairy Herd Management
David Selner ........................................... Secretary and Executive Director, National Dairy Shrine

BREED ASSOCIATION LEADERS

Becky Payne .............................................. Executive Secretary, Ayrshire Breeders Association
David Wallace .............................................. Executive Secretary, Brown Swiss Cattle Breeders Association
David Trotter ............................................. Interim Executive Secretary, American Guernsey Association
John Meyer .............................................. Executive Secretary, Holstein Association USA, Inc.
Neal Smith .............................................. Executive Secretary and CEO, American Jersey Cattle Association
Cory Salzl .............................................. Executive Secretary, American Milking Shorthorn Society

U.S. GOVERNMENT AGRICULTURAL LEADERS

Tom Vilsack .............................................. U.S. Secretary of Agriculture
Sen. Debbie Stabenow (D-MI) ............. Chair, U.S. Senate Agriculture, Nutrition, and Forestry Committee
Rep. Frank Lucas (R-OK) ................. Chair, U.S. House Committee on Agriculture
DAIRY RELATED ORGANIZATIONS

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 Jersey Youth Academy was established in 2009. Its mission is to attract, educate, and retain talented young people for careers in the Jersey dairy business.

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 DHI’s and other herd record providers.

The four Dairy Records Processing Centers (DRPC’s) in the U.S. are:
- AgriTech Analytics
- AgSource Cooperative
- DHI-Provo
- Dairy Records Management Systems

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

Nestlé USA is the largest processor and distributor of milk and dairy products in the U.S.

Nestlé of Switzerland is the top dairy company in the world based on dairy sales.

Danone is the world’s largest yogurt maker.

The New Zealand Dairy Board is the world’s largest private exporter of dairy products.

Items traded at the Chicago Mercantile Exchange daily are:
- Block and barrel cheese (cash)
- Butter futures
- Class III and Class IV milk futures and options

Dairy Management, Inc. (DMI) is a nonprofit organization formed by the National Dairy Board and Unified Dairy Industry Association. It conducts programs in integrated marketing, communications, promotion, and research for U.S. dairy farmers. Organizations under the DMI umbrella are:

- American Dairy Association
- National Dairy Council
- U.S. Dairy Export Council

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 publication. ADSA has two divisions – Dairy Foods and Dairy Production – in its organizational structure.

The three Member Societies that formed the Federation of Animal Science Societies (FASS) in 1998 were:
- American Dairy Science Association (ADSA)
- American Society of Animal Science (ASAS)
- Poultry Science Association (PSA)
Chapter 2: People and Organizations

ORGANIZATION HEADQUARTERS

American Dairy Science Association ................................................................. Champaign, Illinois
Council on Dairy Cattle Breeding ............................................................... Reynoldsburg, Ohio
Dairy Calf and Heifer Association ............................................................... Madison, Wisconsin
*Hoard’s Dairyman* ................................................................................ Fort Atkinson, Wisconsin
Milk and Dairy Beef Quality Assurance Center ........................................ Stratford, Iowa
National Dairy Shrine ................................................................................ Fort Atkinson, Wisconsin
National DHIA ........................................................................................ Verona, Wisconsin
National Milk Producers Federation ......................................................... Arlington, Virginia

EVENT LOCATIONS

All-American Dairy Show ........................................................................ Harrisburg, Pennsylvania
Eastern States Exposition (The Big E) .................................................. West Springfield, Massachusetts
National 4-H Dairy Conference ............................................................ Madison, Wisconsin
North American International Livestock Exposition ......................... Louisville, Kentucky
World Dairy Expo .................................................................................. Madison, Wisconsin
## Chapter 3: Dairy Breeds

<table>
<thead>
<tr>
<th>Breed</th>
<th>Origin</th>
<th>Arrived in U.S.</th>
<th>Mature Bodyweight</th>
<th>Method of Permanent ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayrshire</td>
<td>County of Ayr, Scotland</td>
<td>1822</td>
<td>1,200 lb.</td>
<td>Photograph or sketches</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>Switzerland</td>
<td>1869</td>
<td>1,400 lb.</td>
<td>Ear tattoo</td>
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<tr>
<td>Guernsey</td>
<td>Isle of Guernsey</td>
<td>1831</td>
<td>1,250 lb.</td>
<td>Photograph or sketches</td>
</tr>
<tr>
<td>Holstein</td>
<td>Netherlands &amp; Germany</td>
<td>1852</td>
<td>1,400 lb.</td>
<td>Photograph or sketches</td>
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<tr>
<td>Jersey</td>
<td>Isle of Jersey</td>
<td>1815</td>
<td>1,000 lb.</td>
<td>Ear tag or tattoo</td>
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<tr>
<td>Milking Shorthorn</td>
<td>England</td>
<td>1846</td>
<td>1,400 lb.</td>
<td>Ear tattoo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Breed</th>
<th>Association Name &amp; Headquarters</th>
<th>Magazine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayrshire</td>
<td>Ayrshire Breeders Association Columbus, Ohio</td>
<td>Ayrshire Digest</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>Brown Swiss Cattle Breeders Association Beloit, Wisconsin</td>
<td>Brown Swiss Bulletin</td>
</tr>
<tr>
<td>Guernsey</td>
<td>American Guernsey Association Columbus, Ohio</td>
<td>Guernsey Breeders’ Journal</td>
</tr>
<tr>
<td>Holstein</td>
<td>Holstein Association USA, Inc. Brattleboro, Vermont</td>
<td>Holstein Pulse</td>
</tr>
<tr>
<td>Jersey</td>
<td>American Jersey Cattle Association Reynoldsburg, Ohio</td>
<td>Jersey Journal</td>
</tr>
<tr>
<td>Milking Shorthorn</td>
<td>American Milking Shorthorn Association Beloit, Wisconsin</td>
<td>Milking Shorthorn Journal</td>
</tr>
<tr>
<td>Red and White</td>
<td>Red and White Dairy Cattle Association Clinton, Wisconsin</td>
<td>The Red Bloodlines</td>
</tr>
</tbody>
</table>
Chapter 3: Dairy Breeds

MISCELLANEOUS BREED INFORMATION

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
- Sound feet and legs
- Longevity
- Having few health problems

Guernsey milk is known for its golden color.

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 the most milk per cow.

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

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

World production leaders by breed

Brown Swiss............................................................Lost Elm Prelude Pixy ET (65,430 lb.)
Holstein.................................................................Ever-Green-View My 1326-ET (72,170 lb.)
Jersey .................................................................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

DAIRY GOATS

Capriculture is the study of goats and goat husbandry.

Breeds of dairy goats
- Alpine
- La Mancha
- Nigerian Dwarf
- Nubian
- Oberhasli
- Saanen
- Sable
- Toggenburg

The American Dairy Goat Association is third in total dairy animals registered annually in the United States, following the Holstein and Jersey organizations.
Chapter 4: Dairy Cattle Judging, Fitting and Showing

PDCA DAIRY COW UNIFIED SCORECARD

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
<th>Traits in Priority Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>15</td>
<td>Rump (5)</td>
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<tr>
<td></td>
<td></td>
<td>Front end (5)</td>
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<td></td>
<td></td>
<td>Back/loin (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stature (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Breed characteristics (1)</td>
</tr>
<tr>
<td>Dairy Strength</td>
<td>25</td>
<td>Ribs (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chest (6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barrel (4)</td>
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<td></td>
<td></td>
<td>Thighs (2)</td>
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<td></td>
<td></td>
<td>Neck (2)</td>
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<tr>
<td></td>
<td></td>
<td>Withers (2)</td>
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<td></td>
<td></td>
<td>Skin (1)</td>
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<tr>
<td>Rear Feet and</td>
<td>20</td>
<td>Movement (5)</td>
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<tr>
<td>Legs</td>
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<td>Rear legs – side view (3)</td>
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<td></td>
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<td>Rear legs – rear view (3)</td>
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<tr>
<td></td>
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<td>Feet (3)</td>
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<tr>
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<td>Thurl position (2)</td>
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<td>Hocks (2)</td>
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<tr>
<td></td>
<td></td>
<td>Bone (1)</td>
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<td></td>
<td></td>
<td>Pasterns (1)</td>
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<td>Udder</td>
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<td>Udder depth (10)</td>
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<td>Rear udder (9)*</td>
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<td></td>
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<td>Teat placement (5)</td>
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<td></td>
<td></td>
<td>Udder cleft (5)</td>
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<tr>
<td></td>
<td></td>
<td>Fore udder (5)*</td>
</tr>
<tr>
<td></td>
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<td>Teats (3)</td>
</tr>
<tr>
<td></td>
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<td>Udder balance and texture (3)</td>
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</tbody>
</table>

*In Holsteins, fore & rear udder are weighted equally at 7 points each.

DAIRY HEIFER SCORECARD

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>Frame</td>
<td>40</td>
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<tr>
<td>Dairy Strength</td>
<td>20</td>
</tr>
<tr>
<td>Feet and Legs</td>
<td>30</td>
</tr>
<tr>
<td>Body Capacity</td>
<td>10</td>
</tr>
</tbody>
</table>

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:

- Median suspensory ligament
- Lateral suspensory ligament
- 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.
SHOWMANSHIP

When exhibiting a dairy animal, the parading circle before the judge should move clockwise. When showing a dairy heifer, the rear leg nearest the judge should be placed farther back than the other. When showing a dairy cow, the rear leg nearest the judge should be placed farther forward than the other. One should lead a dairy animal from the left side of the animal when viewed from the rear.

SHOW ETHICS

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

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

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

PDCA SHOWMANSHIP EVALUATION CARD

SLIGHT DISCRIMINATIONS

Exhibitor

- Inappropriate halter
- Lead strap tightly looped
- Walks slowly backward into the ring
- Sidesteps when leading calf
- 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
- 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 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
- Failure to switch rear legs when the judge moves around the animal
- Doesn’t walk quickly into line
- 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
- Legs incorrectly posed
- Does not keep animal straight from head to tail
- 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
Chapter 4: Dairy Cattle Judging, Fitting and Showing

SERIOUS 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 THE EVALUATION OF THE TOPLINE
Topline is groomed, doesn’t distract from the animal’s overall appearance, conforms to the guidelines of the PDCA Showring Code of Ethics

HEIFER CLASSES
The individual heifer classes in a dairy show are:
- Spring heifer calf
- Winter heifer calf
- Fall heifer calf
- Summer yearling heifer
- Spring yearling heifer
- Winter yearling heifer
- Fall yearling heifer

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 is 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.
ACRONYMS

ADG ......................................................................................................................... Average daily gain
AFC ............................................................................................................................... Age at first calving

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.

PROJECT SELECTION

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

- Age
- Breed
- Health
- Pedigree
- Conformation

IDENTIFICATION

Methods commonly used to identify calves include:

- Eartag
- Freeze branding
- Photo
- Sketch
- Tattoo

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.

COLOSTRUM

Colostrum is milk that is secreted during the first two to three days after calving. 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 for the first three days of life. If colostrum is pasteurized, it should be heated to 140°F for 60 minutes. The 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. Conditions that can result in poor quality colostrum include:

- Cow is dry less than 3-4 weeks
- Pre-milking
- Young cow
- Leaking teats
- Dirty udder and teats
Chapter 5: Calf and Heifer Management

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

**WEANING**

Weaning is the act of taking a young animal off of milk as the main source of nutrition.

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

Before weaning a calf should eat at least **1.5 pounds of grain per day for three consecutive days.**

**Calf Starter**

Calf starter should contain 18-22% crude protein.

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

- Commercial textured calf starters
- Commercial pelleted starters
- Home-made grind and mix starters

**Calf Housing**

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

Warm calf housing is housing in which environmental temperature is controlled.

The temperature in cold calf housing varies with the outside temperature.

**Systems of calf housing** include:

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

**Advantages of calf hutches** include:

- They are easily moved
- They provide better ventilation
- They prevent disease from spreading from one calf to another

**GROWTH**

**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.

**Compensatory growth** is a term used to describe a period of increased growth rate that follows a growth restriction imposed earlier in the heifer’s life.
Calf Health

The leading causes of death in young calves are scours and pneumonia. The major causes of calf scours include:

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

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

Places where pathogenic organisms may gain entry into a newborn calf’s body are the mouth, navel, and nose.

Signs of illnesses in calves include:

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

A 7% iodine solution should be painted on the calf’s navel soon after birth to seal the entrance from disease causing organisms.

A calf is 2 to 3 weeks old when it begins to chew its cud. Calves should be dehorned at about three weeks of age.

Methods of dehorning calves are paste (caustic potash), cut or gouge (Barnes type dehorner), and electric.

Extra teats are also known as supernumerary teats. Between 30 and 40 percent of heifers born have extra teats. They should be removed as soon as they can be told apart from the four main teats, or at dehorning time.

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

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

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

Methods of charging for heifer grower services include:

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

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<thead>
<tr>
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<td>Amino acid</td>
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<tr>
<td>ADF</td>
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<td>Acid detergent insoluble nitrogen</td>
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<td>Adenosine diphosphate</td>
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<td>Total digestible nutrients</td>
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<tr>
<td>VFA</td>
<td>Volatile fatty acid</td>
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Chapter 6: Nutrition, Feeds and Feeding

MOUTH
A mature dairy cow has 32 teeth, but has no upper front teeth. Chewing is also known as mastication. Cud is feed that a cow has regurgitated and is being re-chewed. The esophagus is the tube that connects the mouth to the rumen.

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
- Lubricate food
- Provide fluid base for many nutrients
- Provide the proper environment for bacterial growth

RUMINANT
The dairy cow is a ruminant, meaning it has a four-compartment stomach. The stomach compartments are the reticulum, rumen, omasum, and abomasum. Rumination is the process in ruminants when semi-liquid ingested feed is regurgitated into the esophagus, re-chewed, and re-swallowed for further digestion. Eructation is belching of gas by ruminant animals as a natural way for releasing gases produced during the fermentation process.

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. 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. Papillae are tiny, finger-like projections that line the wall of the rumen. Carbon dioxide and methane are gases produced in the rumen. The ideal rumen pH is 5.9 to 6.2. The rumen is acidic 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 also called the true stomach.
The abomasum is the enzyme and acid secreting portion of the ruminant 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.
Villi are the small projections that line the small intestine wall.
Chyme is the feed material found in the small intestine.
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

A nutrient is any chemical substance that provides nourishment to the body.
The main processes for which a cow uses nutrients from her feed are maintenance, growth, production and reproduction.
The nutrients contained in feedstuffs are carbohydrates, fats, protein, minerals, vitamins, and 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.
Digestible energy is the total energy in a feedstuffs minus the energy lost in feces.
Metabolizable energy is digestible energy minus the energy lost in urine and gas.
Net energy is the actual amount of energy the body can use for growth, lactation, reproduction, and body maintenance.

FATS

Fats are the most concentrated energy source in dairy cattle rations. They contain 2.25 times the energy value of starch.
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)
- Whole oil seeds (whole cottonseeds, whole soybeans)
- Protected fats (calcium soaps)

Fatty acids are the building blocks of fats and lipids.
**Saturated fatty acids** are completely hydrogenated; each carbon atom is associated with the maximum number of hydrogen atoms. They have no double bonds.

**Unsaturated fatty acids** are not completely hydrogenated. They have one or more double bonds.

**Whole oil seeds** contain high levels of unsaturated fatty acids.

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**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.

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**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), and 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, and nitrogen.

Most proteins contain **16% nitrogen**.

**Crude protein** is the total protein in a feed. 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.

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

**Rumen undegradable protein (by-pass protein)** is protein that passes through the rumen and is unchanged by microbes.

**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.

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**AMINO ACIDS**

**Amino acids** are the building blocks of true proteins. 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**.

**Essential amino acids** must be provided in the diet.

The **ten essential amino acids** for milking cows are:

- Arginine
- Histidine
- Isoleucine
- Leucine
- Lysine
- Methionine
- Phenylalanine
- Threonine
- Tryptophan
- Valine
Chapter 6: Nutrition, Feeds and Feeding

The **most limiting amino acids** in dairy cattle nutrition are lysine and methionine. **Nonessential amino acids** are produced by the cow and do not have to be provided in the diet.

**MINERALS**

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

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

**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
- Copper
- Iodine
- Iron
- Manganese
- Selenium
- Zinc

**VITAMINS**

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

The **fat-soluble vitamins** are Vitamin A, Vitamin D, Vitamin E, and Vitamin K.

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

**Vitamin E** has functions similar to 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)
- Riboflavin (B₂)
- Niacin (B₃)
- Pantothenic Acid (B₅)
- Biotin (B₇)
- Folic Acid (B₉)
- Choline
- B12

**Vitamin C** is also known as ascorbic acid.

Vitamins are measured in **International Units (IU)**.

**WATER**

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

**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
- Milk production
- Environmental temperature
- Relative humidity
- Water temperature
- Diet

**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).
Chapter 6: Nutrition, Feeds and Feeding

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

NUTRIENT REQUIREMENTS

Many factors are required to determine nutrient requirements of a lactating cow including:
- Body weight
- Age
- Milk production level
- Fat test
- Stage of lactation
- Reproductive status
- Body condition
- Environmental temperature

FORAGES

Forage is the vegetative portion of plants in a fresh, dried, or ensiled state that is fed to livestock.
Baleage refers to wrapped, round bales of silage.
Green chop refers to forage harvested (cut and chopped) in the field and fed directly to livestock.
Hay is dried forage (grasses, alfalfa, clovers) used for feeding farm animals.
Silage (ensilage) is 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.

LEGUMES

Legumes used in dairy rations include:
- Alfalfa
- Bird’s Foot Trefoil
- Clover
- Lespedeza
- Peanuts
- Peas
- Soybeans
- 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
- Higher digestibility
- Greater palatability
- 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.
SILAGE

**Phases of silage fermentation** are:
1. Aerobic
2. Anaerobic
3. Stable
4. Feeding

**Types of silage storage facilities** include:
- Bunker silo
- Trench silo
- Upright/tower silo
- Plastic bag
- Oxygen limiting silo

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, the 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 varieties** have lower lignin concentrations, which increase fiber digestibility.

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

When sampling **square bales of hay** for forage testing, 20 bales should be sampled.
Chapter 6: Nutrition, Feeds and Feeding

DRY MATTER

Dry matter is the portion of a feed that remains after water has been removed by drying in an oven. 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.

FIBER

Fiber is needed in dairy cattle rations to:
- Maximize dry matter and energy intakes
- Maintain normal milkfat 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.

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

MINERAL SUPPLEMENTS

Common mineral supplements include:
- Dicalcium phosphate
- Limestone
- Magnesium oxide
- Monocalcium phosphate
- Potassium chloride
- White salt

Limestone is an excellent source of calcium.

BUFFERS

A buffer is any substance that can reduce changes in pH when an acid or alkali is added.

Reasons one might add buffers to a dairy cow’s ration include:
- Increase fat test
- Aid in adjusting to high-energy ration
- Improve milk quality
- Improve digestibility
- Maintain acid-base balance
- Improve intake

Buffers commonly used in dairy rations include:
- Limestone (calcium carbonate)
- Sodium bentonite
- Magnesium oxide
- Sodium bicarbonate
**DIETARY CATION-ANION DIFFERENCE**

An anion is a negatively charged ion or particle. A cation is a positively charged ion or particle.

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

The elements used to calculate DCAD are Sodium (+), Potassium (+), Chlorine (-), and 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
- Ammonium sulfate
- Calcium chloride
- Calcium sulfate
- Magnesium chloride
- Magnesium sulfate

**IONOPHORES**

Ionophores alter rumen fermentation by boosting the production of propionic acid and reducing the production of acetic acid. Examples are Lasalocid and Monensin. Monensin is approved for use in lactating dairy cattle, but Lasalocid is not.

**BY-PRODUCT FEEDS**

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

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

**By-product feedstuffs** include:

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

**TOTAL MIXED RATION**

A total mixed ration (TMR) is a blend of all feedstuffs (forages & grains) in one feed.

**Advantages of feeding a TMR** include:

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

**GROUPING**

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

- Body condition
- Lactation number
- Production level
- Reproductive status
- Stage of lactation
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
- Low labor requirement
- Even manure distribution
- Reduced soil erosion
- Improved weed control

Disadvantages of grazing include:
- Distance from parlor
- Inconsistent quality
- Inconsistent quantity
- Unable to balance ration properly
- Lower forage yield per acre

BODY CONDITION SCORING

Body condition scoring is a system to evaluate the thinness or fatness of dairy cattle. The score, 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.

Targets for body condition scores at different stages of lactation are:
- At calving .................. 3.0-3.25
- Early lactation ............... 2.5
- Mid lactation .................. 2.75
- Late lactation .................. 3.0
- At drying off .................. 3.0-3.25

MISCELLANEOUS

Feed is the largest cost in milk production.

Palatability is the taste or likability of a feedstuff.

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

Annuals are plants that are seeded each year and whose growth are completed in one crop year.

Perennials are plants that have a life cycle of more than two years.

Raw soybeans will turn rancid if they are ground.

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

Negative energy balance occurs when the amount of energy taken into the body is less than the amount of energy required by the body.

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

An acid is a substance that has a low pH (below 7.0).

An alkaline is a substance that has a high pH (above 7.0).
Chapter 7: Lactation and Milking Management

ACRONYMS

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<td>bST</td>
<td>Bovine somatotropin</td>
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<td>BTMC</td>
<td>Bulk tank milk culture</td>
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<td>BTSCC</td>
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<td>CFM</td>
<td>Cubic feet per minute</td>
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UDDER ANATOMY

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

Myoepithelium is contractile tissue that forces milk out of the alveoli upon action of oxytocin.

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

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

Strutting is the condition in which the teats point out too much.

Supernumerary teats are extra teats.

HORMONES

Adrenaline (epinephrine) can interfere with milk ejection when a cow becomes frightened or upset.

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

Lactation is the period of time when a cow is in milk.

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.
Chapter 7: Lactation and Milking Management

MILKING FACILITIES

Types of milking parlors include:
- Herringbone
- Parabone
- Parallel
- Rotary
- Side opening

The herringbone parlor is the most common type in use today.

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:
- Claw
- Milk tube
- Short air tube
- Teat cup shell
- Teat cup liner (inflation)

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
- Flooded milk lines
- Slow milking
- Squawking teat cups
- Teat cups fall off
- Uneven milk flow
- Vacuum fluctuations
- Milking wet teats

A liner slip is a condition whereby a teat cup slides down the surface of the teat, often accompanied by a squawk. It may be caused by:
- Improper liner design
- Cluster weight
- Vacuum fluctuations
- Milking wet teats

PARTS OF THE MILKING SYSTEM

A milkline is a line that carries milk and air during milking and has the dual function of providing milking vacuum and conveying milk to a receiver.

A looped milkline is a milkline that forms an enclosed circuit with two full-bore connections to the receiver.

A lowline (or low-level) milking system is a system in which the milk inlet to the milkline or receiver jar is below the animal standing level.

A washline is a line that carries cleaning and sanitizing solutions during the cleaning process from the wash sink, vat or tank to the milking units, milkline or milking vacuum line.

A milk meter is a device between the cluster and the milkline for measuring all the milk from an individual animal.

PULSATION

Pulsation is the cyclic opening and closing of a teat cup liner.

The pulsator is the part of the milking system that causes the alternate vacuum pressure between the teat cup shell and liner.

Alternating pulsation is when cyclic movement of the liners of two teat cups within a cluster alternates with the movement of the other two liners.
The pulsation rate is number of times per minute that the pulsator opens and closes. The pulsation ratio is 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.

**VACUUM**

A vacuum pump is an air pump that produces vacuum in the milking system. A vacuum gauge is an instrument to indicate the level of vacuum in the system, relative to atmospheric pressure. A vacuum regulator (vacuum controller) is the part of the milking system that prevents the vacuum level from exceeding a prescribed level. Vacuum pressure at the teat end at the time of milking should be 12 to 13 inches of mercury. A sanitary trap is a vessel between the milk system and the air system to limit movement of liquids and other contaminants between the two systems.

**BULK TANK**

A bulk tank is a large storage tank for cooling and storing milk at a cold temperature until it is transported to a processing plant. It is usually made of stainless steel. An agitator stirs milk in the bulk tank to help with cooling and to provide a uniform product mixture for sampling.

**CLEANING EQUIPMENT**

A standard milking equipment cleaning protocol consists of four phases:

1. Pre-rinse
2. Acid rinse
3. Chlorinated alkaline cleaning
4. Sanitization

The key requirements for adequate, effective cleaning of milking systems are time, temperature, and concentration. The recommended temperature of water for washing the bulk tank, lines, and other equipment is 160°F. A sanitizer is a chemical solution used to kill bacteria on product contact surfaces. Backflushing is a system for sanitizing teat cup liners between cow milkings. Clean-in-place (CIP) is the capability to clean and disinfect the milk-contact components of a milking system by circulating appropriate solutions through them without disassembly. An air injector is a device that allows controlled, cyclic admission of air during cleaning and sanitizing to produce slug flow conditions. Dirty equipment is most frequently the cause of high bacteria counts in milk. Milk stone is a milk-mineral deposit on milk handling equipment.
Chapter 7: Lactation and Milking Management

MILKING-RELATED DEFINITIONS

**Forestripping** is a 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.

**Foremilk** refers to the first streams of milk stripped from the udder prior to milking.

**Milk letdown** is the process through which milk is squeezed out of milk-producing tissue by the action of the hormone, oxytocin.

**Residual milk** is milk remaining in the mammary gland following completion of milking.

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

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.

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:

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

MASTITIS

*Mastitis* is an inflammation of the udder, most commonly caused by infecting microorganisms.

**Inflammation** is a condition in which the cow’s body seeks to eliminate or neutralize invading microorganisms and repair damaged tissue.

**Intramammary infection** is characterized by the presence of microorganisms growing in the udder.
Chapter 7: Lactation and Milking Management

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

**Mastitis** is the most costly 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%)
- Discarded milk (14%)
- Early cow replacement cost (8%)
- Reduced cow sale value (5%)
- Drugs (5%)
- Veterinarian (3%)
- Labor (1%)
- Lost milk premiums (variable)

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

**Subclinical mastitis** is mastitis with no detectable change in the udder itself and no observable abnormality of the milk.

**Clinical mastitis** is characterized by visible abnormalities in the udder or milk.

**Acute mastitis** is characterized by sudden onset, redness, swelling, hardness, pain, grossly abnormal milk, and reduced milk yield.

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

**Symptoms of clinical mastitis** include:
- Flakes
- Clots
- Stringy milk
- Watery milk
- Hot quarter
- Swollen quarter
- Presence of blood

**Ropy milk** is milk that contains strings of white blood cells.

The **California Mastitis Test**, **conductivity**, and **strip cup** are **on-farm screening tests** to detect mastitis.

**Potential causes** of mastitis include:
- Failure to teat dip
- Faulty milking equipment
- Improper dry cow management
- Poor housing/environment
- Poor milking practices
- Poor sanitation
- Stray voltage

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.

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.

**Spontaneous recovery** is the ability of a cow to cure itself of an udder infection without the aid of antibiotics or other drugs.
**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

A **somatic cell count (SCC)** is a measurement most commonly used as an indicator of mastitis. It is an indicator of the extent of subclinical mastitis present in a cow’s udder or number of leukocytes present.

**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*)
- *Streptococcus agalactiae* (*Strep. ag.*)
- *Mycoplasma* species

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

- **Coliforms** include *Escherichia coli* (*E. coli*), *Enterobacter* species, and *Klebsiella* species.
- **Environmental Streptococci** include *Streptococcus dysgalactiae* and *Streptococcus uberis*.

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

**ENVIRONMENT**

Factors affecting the dairy cow’s environment are:

- Climate
- Season of the year
- Frequency and duration of confinement housing
- Management of cows and facilities
- Herd size
- Housing type
- Sources of environmental bacteria in dairy herds are:

  - Soil
  - Water
  - Bedding
  - Feedstuffs
  - Mud
  - Feces
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)
- Antibiotics
- Dirt (from outside of the cow)
- Equipment
- Feed
- Insects
- Interior of udder
- Water

Factors that can influence milk composition include:
- Age of cow
- Environmental temperature
- Genetics
- Nutrition
- Somatic cell count
- Breed
- Estrus
- Milking procedures
- Season
- Stage of lactation

Conditions that will cause a decrease in fat test include:
- Finely chopped feeds
- Low fiber content in ration
- Estrus
- Extremely hot weather
- Illness

Mastitis has an effect on milk composition. Components that decrease in concentration in mastitic milk are:
- Lactose
- Total proteins
- Casein
- Solids not fat
- Total solids
- Fat
- Calcium
- Phosphorus
- Potassium

Components that increase in concentration in mastitic milk are:
- Lipase
- Sodium
- Chloride
- Immunoglobulins
- Leukocytes
- Trace Minerals

DRY PERIOD

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

Involution is the process by which udder tissue reverts to a non-milk-producing state after drying off.

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.

Reasons to treat every quarter of every cow at drying off are:
- Higher concentration of antibiotics (than lactating products)
- Antibiotics remain longer
- No discarding of saleable milk
- Prevent new infections

STRAY VOLTAGE

Stray voltage, small electric currents that flow through the electrical grounded-neutral system and which pass through a cow’s body, adversely affects her behavior and performance.
Milk is nature’s most nearly perfect food.

Milk is **96-98% digestible**.

**Raw milk** is milk as it comes from the cow prior to processing.

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**

**Casein** is the primary protein found in milk.

Milk also contains **whey proteins**.

**Milk taste** improves as the protein level in milk increases.
LACTOSE

Lactose is milk sugar that gives milk its sweet flavor. It is the major solids component of milk. The simple sugars that make up lactose are glucose and galactose.

Lactase is the enzyme needed by humans to digest lactose. Lactose intolerance is the condition when a person cannot metabolize (break down) milk sugar.

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), lowfat (1% fat), and skim milk must be fortified with Vitamin A to be nutritionally similar to 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

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.

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
- 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

Acid degree value detects rancidity.

The *Bacillus stearothermophilus* disc assay is the official test for antibiotic residues.

A cryoscope is an instrument used to test the freezing point of milk to determine if water has been added.

The standard plate count is a test that measures bacterial content of raw milk to monitor milk quality.

The phosphatase test is used to determine if raw milk has been added to pasteurized milk.

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 commonly 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.

Lipase is an enzyme that breaks down butterfat, leading to rancidity.

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.

MILK PROCESSING

Clarification removes solid impurities from milk prior to pasteurization.

Separation is the process of dividing milk into skim milk and cream.

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

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

Fortification is the process by which vitamins are added to milk.
**PASTEURIZATION**

Pasteurization increases the shelf life of milk by substantially reducing the total bacteria population. Pasteurization destroys lipase and other natural milk enzymes, which might cause off-flavor in milk during refrigerated storage.

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 milks to 161°F for 15 seconds.

**BEVERAGE MILKS**

Milk is **labeled** according to the following standards:

<table>
<thead>
<tr>
<th>Label</th>
<th>Other Names</th>
<th>Grams of fat per cup</th>
<th>Calories per cup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat free</td>
<td>Nonfat, skim</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>Lowfat</td>
<td>1% fat</td>
<td>2.5</td>
<td>100</td>
</tr>
<tr>
<td>Reduced fat</td>
<td>2% fat</td>
<td>5</td>
<td>120</td>
</tr>
<tr>
<td>Whole</td>
<td></td>
<td>8</td>
<td>150</td>
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</tbody>
</table>

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

**BUTTER**

Churning is the process that turns cream into 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

**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.

Rennet is a substance containing many enzymes that is obtained from the lining of a calf’s stomach.

Rennin is an enzyme found in rennet that is used to coagulate protein (casein) when making cheese.

Whey is the fluid by-product of cheese making. 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 most popular.

Feta and Roquefort are cheeses made from the milk of animals other than the dairy cow.
Chapter 8: Dairy Products and Milk Marketing

CREAM

Cream is the high fat milk product separated from milk; it must contain at least 18% milk fat.

Cream varieties include:

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

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 products are dairy foods that have been fermented with lactic acid bacteria. Examples include:

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

Yogurt is a mixture of milk (whole, reduced-fat, lowfat, 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.

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.

The federal orders specify minimum prices and conditions under which regulated milk handlers must operate when selling fluid milk products within a specified geographic area.

There are ten Federal Milk Marketing Orders in the United States. Component pricing is used in six of the orders.

The current Federal Milk Marketing Orders are:

- Appalachian
- Arizona
- Central
- Florida
- Mideast
- Northeast
- Pacific Northwest
- Southwest
- Upper Midwest
MILK CLASSES

Milk class describes how milk is used by the processor or in a marketing area.

Class I ........................................................................................................................................... Beverage milks
Class II ............. Fluid cream products, yogurt, and manufactured products (ice cream, cottage cheese)
Class III ................................................................................... Cream cheese and hard manufactured cheese
Class IV ............................................................................................................................................ Butter and milk in dried form

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.

MILK MARKETING DEFINITIONS

Fluid milk refers to packaged dairy products used as beverage milks.

Fluid products is the term traditionally used to define products including beverage milks, fluid cream items, and yogurts.

Fluid utilization is the proportion of Grade A milk in a market used to produce fluid (Class I) milk.

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

Manufacturers are producers of cheese, butter, nonfat dry milk, and other storable dairy products.

Processors are firms that process raw Grade A milk into fluid products.

MILK COOPERATIVES

The top five milk producing cooperatives in the U.S. based on member milk volume in 2012 were:
1. Dairy Farmers of America
2. California Dairies, Inc.
3. Land O’Lakes, Inc.
4. FarmFirst Dairy Cooperative
5. Northwest Dairy Association

The top 50 cooperatives accounted for 78 percent of the milk produced in the U.S. in 2012.

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 10 cents per hundredweight of milk sold.
MAILBOX MILK PRICE

The **mailbox milk price** is the price for milk of average composition and is a weighted average for the market. It accounts for all payments received for milk including performance bonuses and premiums. It also accounts for all deductions such as promotion, hauling, capital retains, and cooperative dues.

ORGANIC DAIRY PRODUCTION

Organic dairy production is a method of production that uses:

- No hormones to promote growth
- No antibiotics
- 100% organic feed
- No mammalian or poultry by-products in feed

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.

**NOP standards for organic livestock production** require:

- Access to pasture throughout the grazing season
- Diet consisting of at least 30% dry matter intake from pasture grazed during the grazing season, totaling at least 120 days

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**.

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

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.

DIETARY GUIDELINES

According to the **2010 Dietary Guidelines for Americans**, one serving of dairy is equivalent to:

- 8 ounce glass of white or flavored milk
- 8 ounce cup of yogurt
- 1 ½ ounces of cheese

**MyPlate** is an illustration of the five food groups in a place setting based on the **2010 Dietary Guidelines for Americans**; it is designed to help consumers make healthier food choices.
ACRONYMS

CTAP ................................................................. Current Test Day Analysis Program
DCR ........................................................................ Data collection rating
DIM ........................................................................ Days in milk
ECM ......................................................................... Energy corrected milk
ERPA .................................................................. Estimated relative producing ability
FCM ........................................................................ Fat corrected milk
ME .............................................................................. Mature equivalent
PCDART ........................................ Personal Computer Direct Access to Records by Telephone
RIP .......................................................................... Record in progress
SMV ...................................................................... Slow moving vehicle
TQM ................................................................. Total quality management

WEIGHTS AND MEASURES

<table>
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<td>A gallon of milk</td>
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<tr>
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<td>2.15 pounds</td>
</tr>
<tr>
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<td>56 pounds</td>
</tr>
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</tr>
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<td>A bushel of soybeans</td>
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<td>A hundredweight (cwt)</td>
<td>100 pounds</td>
</tr>
<tr>
<td>A kilogram</td>
<td>2.2 pounds</td>
</tr>
</tbody>
</table>

U.S. DAIRY INDUSTRY AT A GLANCE IN 2012

Number of licensed dairy farms .......................................................... 49,331
Number of dairy cows* .......................................................... 9.2 million
Milk per cow per year .......................................................... 21,697 pounds
Milk production .......................................................... 200.3 billion pounds

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

STATE RANKINGS FOR DAIRY PRODUCTION IN 2012

Number of dairy cows ...................... 1) California 2) Wisconsin 3) New York 4) Idaho 5) Pennsylvania
Milk per person .............................. 1) Idaho 2) Wisconsin 3) Vermont 4) New Mexico 5) South Dakota
**STATE RANKINGS FOR FORAGE PRODUCTION IN 2012**

Alfalfa production: 1) California 2) Wisconsin 3) Idaho 4) Minnesota 5) South Dakota

**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.
A lactation record is generally adjusted for lactation length, mature equivalent, and 2 times a day milking.

**Lactation records in progress** can be used in calculation of USDA-AIPL 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 amount of information included in a production record and the resulting accuracy level when compared to production records with either less or more information.

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

**Laboratory tests** available through DHI include:

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

**CULLING**

Reasons for culling a dairy cow from the herd include:

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

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

**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 on the basis of patronage.

**Dairy-L** is an electronic dairy discussion group on the Internet.

**Hazard Analysis of Critical Control Points (HACCP)** is a system of quality control that identifies where mistakes often occur.
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 Act of 2014 is the name of the 2014 Farm Bill.

LABOR MANAGEMENT

The minimum wage in the U.S. is $7.25 per hour, effective July 24, 2009.

Selection tools that a dairy manager can use when hiring a new employee include:
- Application forms
- Interviews
- Reference checks
- Work tests
- Trial periods

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

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 longer 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.

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, are able to 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.

FREESTALLS

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

The parts of a freestall include:
- Support post
- Stall partition
- Neck rail
- Brisket board (tube)
- Stall surface (bedding, mattress)
- Rear curb
Chapter 10: Reproduction

ACRONYMS

AI ............................................................................................................................................ Artificial insemination
CIDR .............................................................................................................................................. Controlled internal drug release
CL ........................................................................................................................................................ Corpus luteum
CR ...................................................................................................................................................... Conception rate
ET ..................................................................................................................................................... Embryo transfer
FSH .............................................................................................................................................. In vitro fertilization
GnRH ........................................................................................................................................ Gonadotropin releasing hormone
IVF .............................................................................................................................................. In vitro fertilization
LH ............................................................................................................................................ Luteinizing hormone
MOET ......................................................................................................................... Multiple ovulations, embryo transfer
PGF$_{2\alpha}$ ............................................................................................................................................ Prostaglandin F$_{2\alpha}$
PR ........................................................................................................................................................ Pregnancy rate
SCR ............................................................................................................................................. Sire conception rate
TAI ................................................................................................................................................... Timed artificial insemination

COW’S REPRODUCTIVE TRACT

The parts of the cow’s reproductive tract are:

- Vulva
- Vagina
- Cervix
- Uterus
- Oviduct
- Ovary

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

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.

OVARIES

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.

Ovulation is the process of releasing an ovum from the follicle on the ovary.

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

The corpus luteum is a temporary gland that forms on the ovary after the ovum is released. It is also called yellow body.

FEMALE REPRODUCTIVE HORMONES

Gonadotropin Releasing Hormone (GnRH) is secreted by the hypothalamus. It controls the secretion of pituitary hormones (FSH and LH).

Follicle stimulating hormone (FSH) is secreted by the anterior pituitary gland. It stimulates growth of follicles.
Luteinizing hormone (LH) is secreted by the anterior pituitary gland. It causes the follicle to rupture and then causes the corpus luteum to replace the follicle. It increases dramatically in concentration 24 hours prior to ovulation soon after the onset of estrus.

**Estrogen (E2)** is produced by the follicle. It is necessary for behavioral estrus and peaks at the onset of standing estrus.

**Progesterone (P4)** is produced by the corpus luteum. It is necessary for the maintenance of pregnancy. It inhibits the release of GnRH from the hypothalamus.

**Prostaglandin (PGF)** is produced by the uterus (endometrium). It 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:
1. Estrus – heat period
2. Metestrus – transition
3. Diestrus – corpus luteum present
4. Proestrus – prior to estrus

Follicles develop in a wave-like pattern known as the **follicular wave**. There are five phases of a follicular wave:
1. Recruitment
2. Selection
3. Growth
4. Dominance
5. Regression

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

### ESTRUS

**Estrus** is the period of heat in dairy cattle.

**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.

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

**Anestrus** is the failure to have an estrous cycle. **Poor nutrition** and **uterine infections** are the leading causes.

**Signs of estrus** in dairy cattle include:
- Restlessness
- Bellowing
- Following and smelling another cow
- Mounting other cow
- 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.

**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

Artificial insemination (AI) is the process of freezing semen from a bull and thawing it later to fertilize ova.

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

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

A French straw is a thin cylinder in which frozen semen is preserved.

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.

FERTILIZATION

Fertilization is the process of joining an ovum and a sperm. It takes place in the oviduct.

A zygote is a fertilized ovum.

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

EMBRYO TRANSFER

Embryo transfer is the 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.

A recipient is an animal that received a fertilized ovum from a donor.

Superovulation is the process that involves treating a cow with a hormone (FSH) to increase the number of ova produced.

Transvaginal aspiration uses ultrasonography to view the ovary while removing oocytes through the vagina using a needle. Harvested oocytes are matured and fertilized in vitro.

CONCEPTION RATE

Conception rate is the percent of services (breedings) that result in a pregnancy. Factors affecting a dairy herd’s conception rate include:

- Heat detection accuracy
- Herd (cow) fertility
- Semen (bull) fertility
- Technician competency
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
- Improper insemination technique
- Heat detection errors

PREGNANCY RATE

Pregnancy rate is the percent of cows that become pregnant out of those cows eligible to become pregnant in a given period of time, usually 21 days. It 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.

PLACENTA

The placenta is the structure through which the fetus receives all of its nutrients.

The placenta is attached to the uterus in dairy cattle by maternal caruncles and fetal cotyledons (placentones).

A retained placenta is the condition when the fetal membranes remain attached to the maternal caruncles within the uterus for an extended period of time after calving (greater than 24 hours).

Retained placenta incidence is highest in summer.

GESTATION

Gestation is the period of pregnancy; it begins at fertilization and ends at birth.

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
- Sex of the calf
- Number of calves carried
- Season of the year

Brown Swiss cattle have the longest gestation period.

PARTURITION

Parturition is the act of giving birth.

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
- Relaxation of ligaments at tail head
- Restlessness

The normal birth position of a calf is front feet first with the head between the legs.
MALE REPRODUCTIVE SYSTEM

The main functions of the testes are to produce sperm and produce the male sex hormones. Cryptorchidism is the condition when one or both testes fail to descend from the abdomen into the scrotum, often affecting fertility.

Mature sperm are stored in the epididymus.

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.

The male reproductive hormones include:

- Follicle stimulating hormone (FSH) – stimulates sperm production
- Luteinizing hormone (LH) – stimulates sperm production
- Testosterone – responsible for the male sex drive (libido)

TIME TERMS

Voluntary Waiting Period (VWP) is the time period after calving when the dairy producer chooses not to breed a cow. The most common VWP is 60 days.

Days to first service is the days from calving until first breeding date.

Days open is the days from calving until conception or successful breeding date.

Calving interval is the period of time from one calving to the next calving, usually measured in months. A herd’s average calving interval is influenced by several factors including:

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

SIRE CONCEPTION RATE

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

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
REPRODUCTIVE HEALTH

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

Involvement is the process where the uterus returns to normal size after calving. It usually takes 30 to 45 days after calving for a cow’s reproductive tract to return to normal.

Metrizitis is an infection of the uterus. Endometritis is an inflammation of the uterine lining. Incidence is highest in summer.

Sterility describes the animal that cannot reproduce. Infertility describes the animal that is neither normally fertile nor totally sterile.

Abortion is the premature expulsion of a fetus. Diseases that cause abortions in dairy cattle include:

- Brucellosis
- Campylobacteriosis (Vibriosis)
- Chlamydia
- IBR
- Leptospirosis
- Listeriosis
- Neospora
- Trichomoniasis

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 similar to normal corpora lutea.

Twinning in dairy cattle has several disadvantages including:

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

A freemartin is a sterile heifer born twin to a bull. Ninety percent (90%) of heifers born twin to a bull are sterile.
ACRONYMS

AIPL.................................................................Animal Improvement Programs Laboratory
BAA.................................................................Breed Age Average
BLAD...............................................................Bovine Leukocyte Adhesion Deficiency
BLUP...............................................................Best Linear Unbiased Predictor
CE.................................................................Calving Ease
CM$.................................................................Cheese Merit
CVM...............................................................Complex Vertebral Malformation
DBH...............................................................Difficult Birth in Heifers
DCE.................................................................Daughter Calving Ease
DNA...............................................................Deoxyribonucleic Acid
DPR.................................................................Daughter Pregnancy Rate
DUMPS.........................................................Deficiency of Monophosphate Synthase
EBV.................................................................Estimated Breeding Value
ETA.................................................................Estimated Transmitting Ability
FAIR..............................................................Farm Animal Identification and Records
FM$.................................................................Fluid Merit
FTI.................................................................Functional Trait Index (Jersey)
FUI.................................................................Functional Udder Index (Jersey)
GMD...............................................................Gold Medal Dam (Holstein)
gPTA.............................................................Genomic Predicted Transmitting Ability
JPI.................................................................Jersey Performance Index
MACE.............................................................Multiple-trait Across Country Evaluations
mRNA...........................................................Messenger Ribonucleic Acid
NM$...............................................................Lifetime Net Merit
PA.................................................................Parent Average
PCR.............................................................Polymerase Chain Reaction
PL.................................................................Productive Life
PPR...............................................................Progressive Performance Rating (Brown Swiss)
PPTA..............................................................Predicted Transmitting Ability
PTI.................................................................Production-Type Index (Ayrshire, Guernsey)
RFID............................................................Radio Frequency Identification
RNA.............................................................Ribonucleic Acid
rRNA...........................................................Ribosomal Ribonucleic Acid
RT.................................................................Recessive Tested
RVC.............................................................Rectovaginal Constriction (Jersey)
SB.................................................................Stillbirth
Chapter 11: Genetics

SCE................................................................................................................................... Service Sire Calving Ease
SDM.......................................................................................................................... Spinal Dysmyelination (Brown Swiss)
SMA.......................................................................................................................... Spinal Muscular Atrophy (Brown Swiss)
SNP.......................................................................................................................... Single Nucleotide Polymorphism
TPI................................................................................................................................... Total Performance Index (Holstein)

ANIMAL IDENTIFICATION

Identification is the first step in a herd improvement program.

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.

NAAB CODE FOR SIRES

The NAAB code for a sire has three parts.

1. 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.
   • Genex/CRI...............................1
   • Select Sires.........................7
   • Alta Genetics.......................11
   • Accelerated Genetics.............14
   • ABS Global.........................29

2. The letters indicate the breed.
   • Ayrshire...............................AY
   • Brown Swiss.........................BS
   • Guernsey..............................GU
   • Holstein...............................HO
   • Jersey.................................JE
   • Milking Shorthorn...............MS
   • Red and White.................WW

3. The number following the letters is an individual bull identification number.
   Example: 7HO00543 is the NAAB Code for CARLIN-M IVANHOE BELL.

BASIC GENETICS

A gene is the basic unit of inheritance.

A chromosome is 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. Dairy cattle have 30 pairs of chromosomes.

A locus is the position that a given gene occupies on a chromosome.

An allele is any of the alternative forms of a gene that may occur at a given locus.

Genotype is the genetic make-up of an individual.

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

Heritability (h²) is the measure of the percent of phenotypic differences between animals for a single trait that can be transmitted to offspring.
Predicted Transmitting Ability (PTA) is a measurement of average superiority or inferiority that will be transmitted to an offspring. The genetic make up of a population can be changed by migration, selection, mutation, and chance.

**GENOMICS**

The total genetic content of an organism is known as its **genome**.
Genomics is the study of genes or gene products in an organism.
Proteomics is the study of all of the proteins that genes create.
Gene mapping is the process of determining where genes are located on individual chromosomes.

**RELATIONSHIPS**

A **pedigree** is a record of ancestry.
A **purebred** is a dairy animal whose sire and dam of the same breed are registered or who are eligible to be registered in a herdbook.
A **registration paper or certificate** accompanies a purebred animal and certifies its parentage.
The **sire** determines the sex of a calf.
The technical term used to describe brothers and sisters is **siblings**.

**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)

**GENETIC EVALUATIONS**

The **Council on Dairy Cattle Breeding** publishes U.S. genetic evaluations.
**Official evaluations** in 2014 will be released in April, August and December. **Genomic evaluations** will be 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 most recently updated in January 2010 and is the average PTA of animals born in 2005.
**INTERBULL** is the name of the International Bull Evaluation Service based in Uppsala, Sweden.
**Reliability** is an indicator of the accuracy of genetic evaluations.

**GENETIC INDEXES**

**Lifetime Net Merit (NM$)** is a genetic index. It combines the following traits for **Holsteins** and **Brown Swiss**:
- Fat
- Protein
- Somatic cell score
- Productive life
- Feet and legs composite
- Udder composite
- Body size composite
- Daughter pregnancy rate
- Calving ability*

*NM$ for **other breeds** does not include calving ability.
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
- Type
- Dairy Form
- Udder Composite
- Feet and Leg Composite
- Productive Life
- Somatic Cell Score
- Daughter Pregnancy Rate
- Daughter Calving Ease
- Daughter Stillbirth

Traits used in the Udder Composite Index for Holsteins are:

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

Traits used in the Body Size Composite Index for Holsteins are stature, strength, body depth, and thurl width.

Traits used in the Feet and Legs Composite Index for Holsteins are:

- Rear legs – side view
- Rear legs – rear view
- Foot angle
- Feet and legs score

Traits used in the Dairy Capacity Composite Index for Holsteins are dairy form and 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. The traits included are:

- PTA Protein
- PTA Fat
- Functional Trait Index*
- Productive Life
- PTA Somatic Cell Score
- Daughter Pregnancy Rate

*There are 14 linear traits used for calculating the Functional Trait Index for Jerseys.

The Functional Udder Index serves an indicator of mastitis resistance in Jerseys. It weights the following traits:

- Fore udder
- Rear udder height
- Udder depth
- Udder cleft
- Front teat placement
- Front teat length

<table>
<thead>
<tr>
<th>Brown Swiss</th>
<th>Holstein</th>
<th>Jersey</th>
</tr>
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<tbody>
<tr>
<td>Excellent ..................... 90-94</td>
<td>Excellent ..................... 90-97</td>
<td>Excellent ..................... 90-100</td>
</tr>
<tr>
<td>Good Plus .................. 80-84</td>
<td>Good Plus .................. 80-84</td>
<td>Desirable .................. 70-79</td>
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<td>Good ........................ 75-79</td>
<td>Acceptable ................ 60-69</td>
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<td>Fair .......................... 65-74</td>
<td>Fair .......................... 65-74</td>
<td>Poor .......................... 50-59</td>
</tr>
<tr>
<td>Poor .......................... 60-64</td>
<td>Poor .......................... 50-64</td>
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</tbody>
</table>

**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. **1** = the calf was born alive and was alive 48 hours postpartum
2. **2** = the calf was born dead
3. **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 more or less often.

**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
- Increasing similarity between animals
- Smaller mature size
- More recessive genes exposed
- Slower growth rate

**UNDESIRABLE RECESSIVE TRAITS**

Undesirable recessive traits in **Brown Swiss** cattle are:

- Weaver
- Spiderleg

Undesirable recessive traits in **Holsteins** include:

- Bovine Leukocyte Adhesion Deficiency
- Brachyspina
- Bulldog
- Complex Vertebral Malformations
- DUMPS
- Dwarfism
- Spinal Dysmyelination
- Spinal Muscular Atrophy
- Hairless
- Imperfect Skin
- Mule-Foot (Syndactylism)
- Pink Tooth (Porphyria)
- Prolonged Gestation

Undesirable recessive traits found in **Jerseys** are **Limber Legs** and **Rectovaginal Constriction**.

Undesirable recessive traits have **not been documented** for the **Ayrshire**, **Guernsey**, or **Milking Shorthorn** breeds.
ACRONYMS

BLV ........................................................................................................................................ Bovine Leukosis Virus
BRSV ................................................................................................................ Bovine Respiratory Syncytial Virus
BSE ................................................................................................................ Bovine Spongiform Encephalopathy
BVD ....................................................................................................................................... Bovine Virus Diarrhea
DA .......................................................................................................................................... Displaced Abomasum
ELISA ...................................................................................................................................... Enzyme-Linked Immunosorbent Assay
FARAD ............................................................................................................................. Food Animal Residue Avoidance Databank
IBR ................................................................................................................................. Infectious Bovine Rhinotracheitis
Ig ....................................................................................................................................................... Immunoglobulin
IM .......................................................................................................................................................... Intramuscular
IV .............................................................................................................................................................. Intravenous
MLV ........................................................................................................................................... Modified Live Virus
NAHMS ...................................................................................................................... National Animal Health Monitoring System
PCR ........................................................................................................................................... Polymerase chain reaction
PI-3 ..................................................................................................................................................... Parainfluenza-3

NORMAL STATS FOR DAIRY ANIMALS

Temperature
- Calf = 102.5°F
- 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

Physiology is the branch of biology that deals with the process, activities, and phenomena of life and living organisms.

The basic tissues that make up a cow’s body are connective, epithelium, muscle, and nerve.

The organ systems found in the body are:
- Circulatory
- Respiratory
- Integumentary (skin)
- Nervous
- Digestive
- Endocrine
- Reproductive
- Skeletal
- Muscular

An enzyme is a protein that acts as a catalyst in starting or speeding up specific chemical reactions.

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.

Phagocytosis is the process by which white blood cells engulf microorganisms.

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

The mitochondrion is known as the powerhouse of the cell because all energy is produced in this cell part.
Chapter 12: Animal Health

BLOOD

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. Erythrocytes are more commonly known as red blood cells. They are the only cells that have no nucleus.

DISEASE

A disease is a change in the normal state of the body, or one or more of its organs, which disturbs the proper performance of body functions.

A pathogen is any microorganism that causes disease.

Antibodies (immunoglobulins) are 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.

A carrier is an animal that is infected with a disease but has no clinical symptoms.

A toxin is a poison produced by microorganisms that kills cells.

Diseases can be classified on the basis of their primary cause:

- Environmental
- Genetic
- Infectious
- Metabolic

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

Diseases caused by a clostridial organism include:

- Blackleg
- Malignant edema
- Overeating disease
- Tetanus

Examples of metabolic diseases are:

- Displaced abomasum
- Laminitis
- Retained placenta
- Ketonis
- Milk fever
- White muscle disease

Diseases with a color in their name include:

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

Zoonoses are diseases and infections that are transmitted between vertebrate animals and human beings.

Zoonoses that may be transmitted from cattle to humans include:

- Brucellosis
- Leptospirosis
- Rabies
- Tuberculosis
- Cowpox
- Listeriosis
- Ringworm
- Salmonellosis
# PROPER AND COMMON DISEASE NAMES

<table>
<thead>
<tr>
<th>Proper Name</th>
<th>Common Name</th>
</tr>
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<tbody>
<tr>
<td>Acetonemia</td>
<td>Ketosis</td>
</tr>
<tr>
<td>Bovine spongiform encephalopathy</td>
<td>Mad cow disease</td>
</tr>
<tr>
<td>Brucellosis</td>
<td>Bang’s disease</td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>Twisted stomach</td>
</tr>
<tr>
<td>Dystocia</td>
<td>Calving difficulty</td>
</tr>
<tr>
<td>Fibropapillomatosis</td>
<td>Warts</td>
</tr>
<tr>
<td>Hypocalcemia</td>
<td>Milk fever</td>
</tr>
<tr>
<td>Infectious bovine keratoconjunctivitis</td>
<td>Pinkeye</td>
</tr>
<tr>
<td>Infectious bovine rhinotracheitis</td>
<td>Red nose</td>
</tr>
<tr>
<td>Laminitis</td>
<td>Founder</td>
</tr>
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<td>Listeriosis</td>
<td>Circling disease</td>
</tr>
<tr>
<td>Papillomatous digital dermatitis</td>
<td>Hairy heel warts</td>
</tr>
<tr>
<td>Paratuberculosis</td>
<td>Johne’s disease</td>
</tr>
<tr>
<td>Parturient paresis</td>
<td>Milk fever</td>
</tr>
<tr>
<td>Pneumonic pasteurellosis</td>
<td>Shipping fever</td>
</tr>
<tr>
<td>Pododermatitis</td>
<td>Foot rot</td>
</tr>
<tr>
<td>Traumatic gastritis</td>
<td>Hardware disease</td>
</tr>
</tbody>
</table>

## 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.

A *trocar* is an instrument used to puncture the rumen in cases of bloat.
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 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 lymphocytes counts

BRUCELLOSIS

Brucellosis (Bang’s disease) is caused by a bacterium of the genus Brucella. 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 living organism’s growth and development, preventing them from reproducing.

CRYPTOSPORIDIOSIS

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 cryptosporidiosis 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
Chapter 12: Animal Health

**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 the 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 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:

- Diarrhea
- General un thriftiness
- Soft swelling in the jaw
- Substantial drops in milk production
- Weight loss
- Death
- Susceptibility to other problems such as infertility
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. 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

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 include:
- Aflatoxin
- Zearalenone
- Ochratoxins
- Trichothecenes
- Fumonisins
- Slaframine

Clinical symptoms of mycotoxins in dairy cattle include:
- Abortions
- Infertility
- Unthriftness
- Cystic ovaries
- No milk
- Weight loss
- Feed refusal
- Poor response to therapy
- Silent heats
- Gastrointestinal upsets
- 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

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.

**Internal parasites** in dairy cattle include:

- Lung worms
- Stomach worms
- Round worms
- Liver flukes
- Coccidia
- Brown stomach worm

The brown stomach worm is the most economically detrimental parasite of cattle.

**Anthelminthics** are a class of chemicals used to kill internal parasites.

**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**

**Predisposing causes** of pneumonia in calves include:

- Poor ventilation
- High humidity
- Dirty pens
- Overcrowding
- Wide range of ages in one pen
- Poor nutrition
- 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*

**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
- Coyote
- Raccoon
- Bobcat
- Fox
- 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.

MORBIDITY VS. MORTALITY

Morbidity rate is the number of sick animals during a specified period of time.

Mortality rate is the number of dead animals during a specified period of time.

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.
**ANTIBIOTICS**

*Antibiotics* are chemical agents given to animals that kill or stop growth of bacteria. 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.

**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 canula
- Petroleum jelly
- Sterile bandaging material
- Wash basin
- Syringe and needles

A **balling gun** is an instrument used to give an animal a pill.

**BIOSECURITY**

*Biosecurity* describes 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.
Chapter 13: Nutrient Management

ACRONYMS

BMP ............................................................................................................................... Best management practices
CAFO .................................................................................................................... Concentrated animal feeding operation
CNMP................................................................. Comprehensive nutrient management plan
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 on a daily basis.

**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 in excess of crop requirements.

Factors that affect the nutritive value of manure are:

- Amount of added feed, bedding and water
- Climate
- Crop
- Method of application
- Method of collection
- Method of storage
- Soil characteristics
- Time of application
- Type of feed ration

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 nonpoint sources of nutrient pollution include most farms, agricultural cropland, and suburban lawns receiving fertilizer.

BEST MANAGEMENT PRACTICES

Best management practices (BMP’s) 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 BMP’s. 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 storm water 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 and soil erosion are reduced because the grass growing on the lots uses nutrients and 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
Chapter 13: Nutrient Management

**BEDDING MATERIALS**

Common dairy cattle *bedding materials* include:

- Newspaper
- Recycled manure solids
- Sand
- Sawdust (green or kiln-dried)
- Shavings
- Straw

**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 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, and 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
- Doesn’t 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.
Appendix: Suggested Reading


