2011 Virginia 4-H Dairy Quiz Bowl Materials

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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

1600’s
1611 First cows arrived at the Jamestown Colony
1624 First cows arrived at the Plymouth Colony

1801-1860
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
1856 First commercial butter factory established in New York
1857 First successful condensory built by Gail Borden in Burrville, Connecticut

1861-1880
1865 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

1881-1900
1884 Milk bottle invented
1885 Hoard’s Dairyman magazine first published
1885 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

1901-1915
1905 First cow testing association in the U.S. organized in Michigan
1906 American Dairy Science Association founded
1906 First National Dairy Show held in Chicago
1906 Brown Swiss cattle recognized as an official dairy breed in the United States
1906 National Dairy Council organized
1914 Smith Lever Act signed establishing the Cooperative Extension Service
<table>
<thead>
<tr>
<th>Dates in Dairy History</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1916-1930</strong></td>
</tr>
<tr>
<td>1916 National Milk Producers Federation founded</td>
</tr>
<tr>
<td>1917 <em>Journal of Dairy Science</em> first published</td>
</tr>
<tr>
<td>1922 Capper Volstead Act passed by Congress to empower farmers and agricultural producers to market, price, and sell their products through cooperative means</td>
</tr>
<tr>
<td>1926 Dairy Herd Improvement testing program started</td>
</tr>
<tr>
<td>1930 <em>Hoard's Dairyman</em> cow judging contest begun</td>
</tr>
<tr>
<td><strong>1931-1937</strong></td>
</tr>
<tr>
<td>1932 First plastic coated paper milk cartons introduced commercially</td>
</tr>
<tr>
<td>1935 National Cooperative Sire Proving Program initiated</td>
</tr>
<tr>
<td>1936 First dairy cattle A.I. organization in Denmark</td>
</tr>
<tr>
<td>1937 First list of sires proven in DHIA testing published by USDA</td>
</tr>
<tr>
<td>1937 Federal Agricultural Marketing Act which provides basis for federal milk marketing orders passed</td>
</tr>
<tr>
<td><strong>1938-1940</strong></td>
</tr>
<tr>
<td>1938 Artificial insemination began in the U.S.</td>
</tr>
<tr>
<td>1938 First A.I. cooperative in the U.S. was organized in New Jersey by E. J. Perry</td>
</tr>
<tr>
<td>1938 First bulk tanks used on farms</td>
</tr>
<tr>
<td>1940 American Dairy Association founded</td>
</tr>
<tr>
<td>1940 Purebred Dairy Cattle Association formed</td>
</tr>
<tr>
<td><strong>1941-1950</strong></td>
</tr>
<tr>
<td>1942 National Association of Animal Breeders organized</td>
</tr>
<tr>
<td>1943 The PDCA Dairy Cow Unified Score Card was first copyrighted</td>
</tr>
<tr>
<td>1945 First edition of the National Research Council's <em>Nutrient Requirements of Dairy Cattle</em> was published</td>
</tr>
<tr>
<td>1949 National Dairy Shrine founded</td>
</tr>
<tr>
<td><strong>1951-1960</strong></td>
</tr>
<tr>
<td>1951 Computer first used to calculate DHIA records in Utah</td>
</tr>
<tr>
<td>1951 First U.S. young sire sampling program established</td>
</tr>
<tr>
<td>1951 First successful embryo transfer in dairy cattle</td>
</tr>
<tr>
<td>1951 First commercial milk replacer for calves introduced</td>
</tr>
<tr>
<td>1953 Frosty, the first U.S. calf resulting from frozen semen born</td>
</tr>
<tr>
<td>1955 Flavor control equipment introduced commercially</td>
</tr>
<tr>
<td>1960 National Mastitis Council founded</td>
</tr>
<tr>
<td><strong>1961-1980</strong></td>
</tr>
<tr>
<td>1964 Commercial introduction of plastic milk jug</td>
</tr>
<tr>
<td>1964 Red and White Dairy Cattle Association organized</td>
</tr>
<tr>
<td>1965 National Dairy Herd Improvement Association organized</td>
</tr>
<tr>
<td>1967 World Dairy Expo founded and holds first show</td>
</tr>
<tr>
<td>1974 Nutrition labeling of fluid milk products begins</td>
</tr>
</tbody>
</table>
### 1981-1990

- **1983** INTERBULL developed
- **1983** *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

### 1991-2000

- **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
- **2000** Federal Milk Marketing Orders reformed to reduce the number of orders

### 2001-present

- **2001** National Research Council’s *Nutrient Requirements of Dairy Cattle* most recently updated (7th revised ed.)
- **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
- **2009** Genomic predictions of genetic merit officially released by USDA-AIPL
Chapter 2: People and Organizations

2011 Virginia 4-H Dairy Quiz Bowl Study Materials

Acronyms

ADA American Dairy Association
ADSA American Dairy Science Association
AFACT American Farmers for the Advancement and Conservation of Technology
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

Acronyms

CME Chicago Mercantile Exchange
CSS Certified Semen Services
DCHA Dairy Calf and Heifer Association
DCRC Dairy Cattle Reproductive Council
DHIA Dairy Herd Improvement Association
DHIR Dairy Herd Improvement Registry
DRPC Dairy Records Processing Center
DRINC Dairy Research, Inc.
EPA Environmental Protection Agency
FASS Federation of Animal Science Societies

Acronyms

NCIMS National Conference of Interstate Milk Shipments
NDC National Dairy Council
NDHIA National Dairy Herd Improvement Association
NDPRB National Dairy Promotion and Research Board
NMC National Mastitis Council
NMPF National Milk Producers Federation
NRC National Research Council
NRCS Natural Resource Conservation Service (USDA)
PDCA Purebred Dairy Cattle Association
PETA People for the Ethical Treatment of Animals

Acronyms

SWCD Soil and Water Conservation District
UDIA United Dairy Industry Association
USDA United States Department of Agriculture
USDEC United States Dairy Export Council
YDLI Young Dairy Leaders Institute
Dairy industry pioneers

S. M. Babcock Developed the butterfat test that was the basis for DHIA testing.
Gail Borden Received the first patent for condensed milk.
Dr. 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.

U.S. Government Agricultural Leaders

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

Breed association leaders

Becky Payne Executive Secretary Ayrshire Breeders Association
David Wallace Executive Secretary Brown Swiss Cattle Breeders Association
Seth Johnson Executive Secretary-Treasurer American Guernsey Cattle Association
John Meyer Executive Secretary Holstein Association USA, Inc.
Neal Smith Executive Secretary and CEO American Jersey Cattle Association

Breed association leaders

David Kendall Executive Secretary American Milking Shorthorn Society
Nicole Stout Executive Secretary-Treasurer Red & White Dairy Cattle Association

Dairy industry leaders

Mark Clarke General Manager World Dairy Expo
Jerry Kozak President and CEO National Milk Producers Federation
Steve Larson Managing Editor Hoard's Dairyman
Thomas Quafle Editor Dairy Herd Management

Organization headquarters

American Dairy Science Association Champaign, Illinois
Dairy Calf and Heifer Association Chesterfield, Missouri
Hoard's Dairyman Fort Atkinson, Wisconsin
Milk & 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

Dairy-related organizations

All-Jersey Sales Corporation is involved with cattle marketing.
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 Holstein Foundation’s education leadership development and outreach programs serve youth and young adults representing all breeds of dairy cattle.
Items traded at the Chicago Mercantile Exchange daily are:
- Block and barrel cheese (cash)
- Class III and Class IV milk futures and options
- Butter futures

Dairy-related organizations

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

There are four Dairy Records Processing Centers (DRPC’s) in the United States. They are:
- Agri Tech Analytics
- Ag Source Cooperative
- DHI-Provo
- Dairy Records Management Systems

Dairy-related organizations

Dairy Farmers of America (DFA) is the largest dairy cooperative in the U.S.
Dean Foods is the largest processor and distributor of milk and other dairy products in the U.S.
Nestle of Switzerland is the top dairy company in the world based on dairy sales.
The New Zealand Dairy Board is the world’s largest private exporter of dairy products.

Dairy Management, Inc. (DMI)

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

Federation of Animal Science Societies (FASS)

FASS was formed by mutual consent and for the mutual benefit of its founding Member Societies:
- American Dairy Science Association (ADSA)
- American Society of Animal Science (ASAS)
- Poultry Science Association (PSA)
Chapter 3: Dairy Breeds

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Ayrshire

- **Origin**: County of Ayr, Scotland
- **Arrived in U.S.**: 1822
- **Mature bodyweight**: 1,200 pounds
- **Method of permanent ID**: Photographs or sketches
- **Association name**: Ayrshire Breeders Association
- **Association headquarters**: Columbus, Ohio
- **Magazine**: Ayrshire Digest

Brown Swiss

- **Origin**: Switzerland
- **Arrived in U.S.**: 1869
- **Mature bodyweight**: 1,400 pounds
- **Method of permanent ID**: Ear tattoo
- **Association name**: Brown Swiss Cattle Breeders Association
- **Association headquarters**: Beloit, Wisconsin
- **Magazine**: Brown Swiss Bulletin

Guernsey

- **Origin**: Isle of Guernsey
- **Arrived in U.S.**: 1831
- **Mature bodyweight**: 1,250 pounds
- **Method of permanent ID**: Photographs or sketches
- **Association name**: American Guernsey Association
- **Association headquarters**: Columbus, Ohio
- **Magazine**: Guernsey Breeders’ Journal

Holstein

- **Origin**: Netherlands and Germany
- **Arrived in U.S.**: 1852
- **Mature bodyweight**: 1,400 pounds
- **Method of permanent ID**: Photographs or sketches
- **Association name**: Holstein Association USA, Inc.
- **Association headquarters**: Brattleboro, Vermont
- **Magazine**: Holstein Pulse

Jersey

- **Origin**: Isle of Jersey
- **Arrived in U.S.**: 1815
- **Mature bodyweight**: 1,000 pounds
- **Method of permanent ID**: Ear tag or tattoo
- **Association name**: American Jersey Cattle Association
- **Association headquarters**: Reynoldsburg, Ohio
- **Magazine**: Jersey Journal
Milking Shorthorn

<table>
<thead>
<tr>
<th>Origin</th>
<th>Arrived in U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>1846</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mature bodyweight</th>
<th>Method of permanent ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,400 pounds</td>
<td>Ear tattoo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Association name</th>
<th>Association headquarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Milking Shorthorn Association</td>
<td>Beloit, Wisconsin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Magazine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking Shorthorn Journal</td>
</tr>
</tbody>
</table>

Red and White

<table>
<thead>
<tr>
<th>Association name</th>
<th>Red and White Dairy Cattle Association</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Association headquarters</th>
<th>Clinton, Wisconsin</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Magazine</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Red Bloodlines</td>
</tr>
</tbody>
</table>

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.

Miscellaneous breed information

- **Brown Swiss** were originally used for milk, meat and draft purposes.
- **Holsteins** make up about 90% of the US 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.
- Guernsey milk is known for its golden color.
- Jerseys generally produce milk with the highest fat and protein content.
- Brown Swiss are known for:
  1. High protein to fat ratio
  2. Sound feet and legs
  3. Longevity
  4. Having few health problems

Notable animals

<table>
<thead>
<tr>
<th>World production leaders by breed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Swiss: Lost Elm Prelude Pixy ET (58,826 lb.)</td>
</tr>
<tr>
<td>Holstein: Ever-Green-View My 1326-ET (72,170 lb.)</td>
</tr>
<tr>
<td>Jersey: Mainstream Barkly Jubilee (55,590 lb.)</td>
</tr>
</tbody>
</table>

The Queen Mother of the Brown Swiss breed is Jane of Vernon.

The first bull to produce one million units of semen was Fisher-Place Mandingo.

Dairy goats

**Capriculture** is the study of goats and goat husbandry.

**Breeds of dairy goats**

1. Alpine
2. La Mancha
3. Nubian
4. Oberhasli
5. Saanen
6. Toggenburg
Chapter 4: Dairy Cattle Judging, Fitting, and Showing

2011 Virginia 4-H Dairy Quiz Bowl Study Materials

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); Front end (5); Back/loin (2); Stature (2); Breed characteristics (1)</td>
</tr>
<tr>
<td>Dairy Strength</td>
<td>25</td>
<td>Ribs (8); Chest (6); Barrel (4); Thighs (2); Neck (2); Withers (2); Skin (1)</td>
</tr>
<tr>
<td>Rear Feet and Legs</td>
<td>20</td>
<td>Movement (5); Rear legs – side view (3); Rear legs – rear view (3); Feet (3); Thurl position (2); Hocks (2); Bone (1); Pasterns (1)</td>
</tr>
<tr>
<td>Udder</td>
<td>40</td>
<td>Udder depth (10); Rear udder (9)<em>; Teat placement (5); Udder cleft (5); Fore udder (5)</em>; Teats (3); Udder balance and texture (3)</td>
</tr>
</tbody>
</table>

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

Dairy Heifer Scorecard

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>40</td>
</tr>
<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>

PDCA Fitting and Showing Scorecard

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance of animal</td>
<td>30</td>
</tr>
<tr>
<td>Appearance of exhibitor</td>
<td>10</td>
</tr>
<tr>
<td>Presentation of animal</td>
<td>60</td>
</tr>
</tbody>
</table>

Items that a judge looks for when judging a fitting and showmanship contest include:

- Animal's condition
- Cleanliness
- Clipping
- Grooming
- Appearance of exhibitor
- Leading the animal
- Posing the animal
- Showing the animal to best advantage
- Poise, alertness, and attitude

Showing guidelines

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:

1. Blind quarter
2. Freemartin heifer
3. Permanent lameness
4. Tampering to conceal faults
5. Total blindness

Ohio was the first state to make tampering with show cows a crime.
Heifer classes in a dairy show

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

Anatomy related to judging

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

The main udder supports are:
1. Skin
2. Median suspensory ligament
3. Lateral suspensory ligament

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

The subcutaneous abdominal veins are also called the milk veins.

Judging 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.
Chapter 5: Calf and Heifer Management

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

There are several important points to consider when selecting a calf as a project animal. They include:

1. Age
2. Breed
3. Health
4. Pedigree
5. Conformation

Identification

Methods commonly used to identify calves include:

- Eartags
- Freeze branding
- Photos
- Sketch
- Tattoo

Liquid diet

Liquid diet choices for pre-weaned calves include:

1. Milk replacer
2. Whole milk
3. Colostrum

A pre-weaned calf should have 8 to 10 percent of its body weight in milk or milk replacer daily.

Colostrum

Colostrum is milk that is secreted during the first two to three days after calving.

It 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.
Colostrum management

Critical factors in colostrum management:
1. Quantity
2. Quality
3. Timing
4. Cleanliness

Storage options for excess colostrum:
1. Add preservative acid
2. Ferment
3. Freeze (may be safely stored frozen for a year)
4. Refrigerate

Colostrum quality

A colostrometer is a device used to measure the antibodies in colostrum.

Conditions that can result in poor quality colostrum:
1. Cow dry less than 3-4 weeks
2. Pre-milking
3. Young cow
4. Leaking teats
5. Dirty udder and teats

Milk replacer

Recommended nutritional content of milk replacer

<table>
<thead>
<tr>
<th>Program</th>
<th>Crude Protein</th>
<th>Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Accelerated</td>
<td>26-30%</td>
<td>15-25%</td>
</tr>
</tbody>
</table>

Recommended protein sources for milk replacers
1. Casein
2. Dried skim milk
3. Dried whey
4. Dried whey product
5. Dried whey protein concentrate
6. Soy protein concentrate
7. Soy protein isolate
8. Dried whey protein concentrate
9. Modified whey protein
10. Protein modified soy flour

Miscellaneous

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.

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

The common names for the stages of a female dairy animal’s life from birth to weaning are:
1. Calf
2. Heifer
3. Cow

Weaning

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

The main criterion for deciding when to wean a calf should be grain intake.

A calf should consume a minimum of 1.5 pounds of grain per day for three consecutive days before weaning.

Calf starter

The recommended crude protein content for calf starter is 18-22%.

There are several types of calf starters available.
1. Commercial textured calf starters
2. Commercial pelleted starters
3. Home-made grind and mix starters
Growth

Average Daily Gain (ADG) is a significant factor in monitoring growth rates in dairy heifers. The most important factor to consider in determining when to breed a heifer for the first time is body size. Heifers usually show heats at 40% of mature bodyweight. They should start being bred at 55% of mature bodyweight and hopefully calve for the first time at 82% of mature bodyweight. Compensatory growth is a term used to describe a period of increased growth rate that follows a growth restriction imposed early in the heifer’s life.

Calf housing

Calf housing should be:
1. Clean
2. Dry
3. Draft-free
4. Well-ventilated

Warm calf housing is housing in which environmental temperature is controlled. The temperature in cold calf housing varies with the outside temperature.

Health

Scours and pneumonia are the leading causes of death in young calves.

Major causes of calf scours:
1. Inadequate colostrum
2. Poor quality milk replacer
3. Unsanitary calving conditions
4. Overfeeding
5. Poor quality colostrum
6. Overcrowding
7. Inadequate ventilation

Physical factors contributing to pneumonia in calves:
1. Drafts
2. Chilling
3. Dampness
4. Poor ventilation

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

Preventative measures

A 7% iodine solution should be painted on the calf’s navel soon after birth to seal the entrance from disease causing organisms. Calves should be dehorned at about three weeks of age.

Methods of dehorning calves:
1. Paste (caustic potash)
2. Electric
3. Cut or gouge (Barnes type dehorner)

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.

Signs of illnesses in calves

1. Poor appetite
2. Cough
3. Watery manure
4. Nasal discharge
5. Drooping ears
6. Dull eyes
7. Lack of energy
8. Elevated temperature

Custom dairy heifer rearing

Custom heifer growing offers several advantages to dairy producers who have been raising their own replacements.
1. Decreased labor requirement
2. Increased milking herd management
3. Increased facility capacity for milking cows
4. Herd expansion without capital investment with use of existing facilities
5. Increased feed inventory for milking cows
6. Potential for better replacement heifers
**Custom dairy heifer rearing**

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

1. Time period
2. Billing and payment procedures
3. Definition of each party’s responsibility
4. Amendments, renegotiations, and renewal
5. Conditions for termination of agreement

**Methods of charging** for heifer grower services include:

1. Per animal per day
2. Per animal
3. Per pound of gain
4. Feed plus yardage
5. Option to purchase
### Chapter 6: Nutrition, Feeds, and Feeding

#### Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>amino acid</td>
</tr>
<tr>
<td>ADF</td>
<td>acid detergent fiber</td>
</tr>
<tr>
<td>ADIN</td>
<td>acid detergent insoluble nitrogen</td>
</tr>
<tr>
<td>ADP</td>
<td>adenosine diphosphate</td>
</tr>
<tr>
<td>AMP</td>
<td>adenosine monophosphate</td>
</tr>
<tr>
<td>ATP</td>
<td>adenosine triphosphate</td>
</tr>
<tr>
<td>BCS</td>
<td>body condition score</td>
</tr>
<tr>
<td>BHBA</td>
<td>beta hydroxybutyrate</td>
</tr>
<tr>
<td>BUN</td>
<td>blood urea nitrogen</td>
</tr>
<tr>
<td>CF</td>
<td>crude fiber</td>
</tr>
<tr>
<td>CP</td>
<td>crude protein</td>
</tr>
<tr>
<td>DCAD</td>
<td>dietary cation-anion difference</td>
</tr>
<tr>
<td>DE</td>
<td>digestible energy</td>
</tr>
<tr>
<td>DM</td>
<td>dry matter</td>
</tr>
<tr>
<td>DMI</td>
<td>dry matter intake</td>
</tr>
<tr>
<td>FFA</td>
<td>free fatty acid</td>
</tr>
<tr>
<td>ME</td>
<td>metabolizable energy</td>
</tr>
<tr>
<td>MUN</td>
<td>milk urea nitrogen</td>
</tr>
<tr>
<td>NDF</td>
<td>neutral detergent fiber</td>
</tr>
<tr>
<td>NDIN</td>
<td>neutral detergent insoluble nitrogen</td>
</tr>
<tr>
<td>NE&lt;sub&gt;g&lt;/sub&gt;</td>
<td>net energy for growth</td>
</tr>
<tr>
<td>NE&lt;sub&gt;i&lt;/sub&gt;</td>
<td>net energy for lactation</td>
</tr>
<tr>
<td>NE&lt;sub&gt;m&lt;/sub&gt;</td>
<td>net energy for maintenance</td>
</tr>
<tr>
<td>NEFA</td>
<td>non-esterified fatty acid</td>
</tr>
<tr>
<td>NFC</td>
<td>nonfiber carbohydrates</td>
</tr>
<tr>
<td>NIR</td>
<td>near-infrared reflectance</td>
</tr>
<tr>
<td>NPN</td>
<td>nonprotein nitrogen</td>
</tr>
<tr>
<td>NSC</td>
<td>nonstructural carbohydrates</td>
</tr>
<tr>
<td>PUN</td>
<td>plasma urea nitrogen</td>
</tr>
<tr>
<td>RDP</td>
<td>rumen-degradable protein</td>
</tr>
<tr>
<td>RFQ</td>
<td>relative forage quality</td>
</tr>
<tr>
<td>RFV</td>
<td>relative feed value</td>
</tr>
<tr>
<td>RUP</td>
<td>rumen-undegradable protein</td>
</tr>
<tr>
<td>TDN</td>
<td>total digestible nutrients</td>
</tr>
<tr>
<td>TMR</td>
<td>total mixed ration</td>
</tr>
<tr>
<td>VFA</td>
<td>volatile fatty acid</td>
</tr>
</tbody>
</table>

#### A mouthful...

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. 

Eructation is belching of gas by ruminant animals as a natural way for releasing gases produced during the fermentation process. 

Rumination is the process in ruminants when semi-liquid ingesta is regurgitated into the esophagus, re-chewed, and re-swallowed for further digestion. 

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 include:
- Moistens food
- Lubricates food
- Acts as a buffer
- Provides fluid base for many nutrients
- Provides the proper environment for bacterial growth

Rumen

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.

The primary process that takes place in the rumen is fermentation. Bacteria, fungi, and protozoa are types of organisms that live in the rumen and digest feed.

The tiny, finger-like projections that line the wall of the rumen are called papillae.

Carbon dioxide and methane are gases produced in the rumen.

Small Intestine

The segments of the small intestine are the:
- Duodenum
- Jejunum
- Ileum

Villi are the small projections that line the small intestine wall. The feed material found in the small intestine is called chyme.

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:
- Growth
- Maintenance
- Production
- Reproduction

The major nutrients contained in feedstuffs are:
- Energy
- Protein
- Vitamins
- Minerals
- Water

Energy is most likely to be the limiting nutrient for the high producing dairy cow. Fats and carbohydrates are major sources of energy for the dairy cow.
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)
- Protected fats (calcium soaps)
- Whole oil seeds (whole cottonseeds, whole soybeans)

Fatty Acids

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. There are no double bonds.
- Unsaturated fatty acids have one or more double bonds. They are not completely hydrogenated.
- Whole oil seeds contain high levels of unsaturated fatty acids.

Carbohydrates

The basic elements contained in carbohydrates are:

- Carbon
- Hydrogen
- Oxygen
- Nitrigen

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

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

Volatile Fatty Acids

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

The main volatile fatty acids produced in the rumen are:

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

Acetic acid is the primary source of energy and milkfat. Propionic acid is produced from digestion of starch and grain. It is a precursor for glucose.

Protein

The basic elements that are present in all proteins are:

- Carbon
- Hydrogen
- Oxygen
- Nitrogen

Most proteins contain 16% nitrogen.

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

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

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 of a ruminant animal and is unchanged by microbes.
Amino Acids

Amino acids are the building blocks of true proteins. There are 20 standard amino acids. The cow’s two 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. Nonessential amino acids are produced by the cow and do not have to be provided in the diet.

Ten essential amino acids for milking cows

<table>
<thead>
<tr>
<th>Phenylalanine</th>
<th>Valine</th>
<th>Tryptophan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threonine</td>
<td>Isoleucine</td>
<td>Methionine*</td>
</tr>
<tr>
<td>Histidine</td>
<td>Arginine</td>
<td>Leucine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lysine*</td>
</tr>
</tbody>
</table>

* Most limiting amino acids in dairy cattle nutrition.

Vitamins

Vitamins are measured in International Units (IU).

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

Vitamin C is also known as ascorbic acid.

Vitamin E has functions similar to selenium.

Vitamin K plays a role in the coagulation of blood.

Minerals

Macrominerals are generally required by the body in relatively large quantities. Requirements are usually stated as a percent of ration dry matter.

<table>
<thead>
<tr>
<th>Calcium</th>
<th>Chlorine</th>
<th>Magnesium</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium*</td>
<td>Sodium</td>
<td>Sulfur</td>
<td></td>
</tr>
</tbody>
</table>

* Needed by the dairy cow in the largest quantity

Microminerals (also known as trace minerals) are required by the body in relatively small quantities. Requirements are usually stated in parts per million (ppm).

<table>
<thead>
<tr>
<th>Cobalt</th>
<th>Copper</th>
<th>Iodine</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese</td>
<td>Selenium</td>
<td>Zinc</td>
<td></td>
</tr>
</tbody>
</table>

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.

Factors influencing the amount of water consumed by dairy cattle

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

Peak times for water consumption

1. As soon as cows leave the milking parlor
2. When cows consume large amounts of dry matter (at feeding)

Water

Physiological functions of water in the body include:

1. A medium to transport nutrients
2. To carry waste products to the point of excretion
3. To cool the body at high environmental temperatures
4. Functions as a universal solvent
5. Serves as a fluid to lubricate joints
6. Serves as a fluid base for milk
7. Serves as a substrate for metabolic reactions

A dairy cow excretes or loses water through:

1. Breathing
2. Sweat
3. Feces
4. Urine
5. Milk
Forage analysis or testing

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

Forage testing methods include:
1. NIR
2. Wet chemistry

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

Ash is the mineral matter present in feed.

Dry matter

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

Items needed to do a quick and easy dry matter determination on a forage at home:

- Microwave oven
- Gram scale
- Paper plate
- Water glass

Measures of energy

Calorie = unit of measure of energy in a feed; the amount of energy required to raise 1 gram of water 1°C.

Digestible energy = total energy in a feedstuff minus the energy lost in feces.

Metabolizable energy = digestible energy minus the energy lost in urine and gas.

Net energy = the actual amount of energy the body can use for growth, lactation, reproduction, and body maintenance.

Fiber

Fiber is needed in dairy cattle rations to:
1. Maximize dry matter and energy intakes
2. Maintain normal rumen function
3. Maintain normal milkfat percentage
4. Protect against postcalving difficulties

The digestibility of plant fiber decreases as the plant increases in age or in hot weather.

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

By-product feeds

By-products can be successfully used as feed for dairy cattle.

Nutrient composition, cost, availability, palatability, storage, consistency, and ability to feed (use) are factors that should be considered before including a by-product in the ration.

<table>
<thead>
<tr>
<th>By-product feedstuff examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed hulls</td>
</tr>
<tr>
<td>Dried brewers grain</td>
</tr>
<tr>
<td>Soybean hulls</td>
</tr>
<tr>
<td>Wheat middlings</td>
</tr>
</tbody>
</table>

Protein sources

Proteins derived from poultry, marine or vegetable sources can be used in ruminant rations because of concerns about Mad Cow Disease.
Common mineral supplements

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

*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:

1. Increase fat test
2. Aid in adjusting to high energy ration
3. Improve milk quality
4. Improve digestibility
5. Maintain acid-base balance
6. Improve intake

Buffers commonly used in dairy rations include:

1. Limestone (calcium carbonate)
2. Sodium bentonite
3. Magnesium oxide
4. Sodium bicarbonate

Ionophores

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

1. Lasalocid (not approved for use in lactating dairy cattle)
2. Monensin (approved for use in lactating dairy cattle)

Nutrient requirements

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

1. Body weight
2. Age
3. Milk production level
4. Fat test
5. Stage of lactation
6. Reproductive status
7. Body condition
8. Environmental temperature

Total mixed ration (TMR)

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

Advantages of feeding a total mixed ration include:

- Eliminate selective eating
- Consistent ration
- Higher 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

Uses for a forage particle separator

- Evaluate whether there is enough long fiber in the ration
- Check for overmixing 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
Factors that may be considered when grouping the milking herd

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

Dietary Cation-Anion Difference (DCAD)

DCAD is a helpful tool in milk fever prevention. An anion is a negatively charged ion or particle. A cation is a positively charged ion or particle. The elements used to calculate DCAD are:

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

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

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

\[ \text{DCAD} = \text{Ca}^+ + \text{K}^+ - \text{Cl}^- - \text{S}^- \]

pH

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).

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

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

Forages

Forage = the vegetative portion of plants in a fresh, dried, or ensiled state that is fed to livestock.

Baleage = wrapped, round bales of silage.

Green chop = forages harvested (cut and chopped) in the field and fed directly to livestock.

Hay = dried forage (grasses, alfalfa, clovers) used for feeding farm animals.

Silage (ensilage) = green forage that is chopped 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.

Grazing

Surveys indicate that the most common reason that farm owners adopted grazing was to reduce costs.

The main costs cited for reduction were:

- Feed
- Labor

Disadvantages of grazing:

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

Immature hay is more valuable as a feed for dairy cows than mature hay because of:
1. Higher nutrient content
2. Higher digestibility
3. Greater voluntary intake (more palatable)
4. 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 phase
2. Anaerobic phase
3. Stable phase
4. Feeding phase

Types of silage storage facilities include:
1. Bunker silo
2. Trench silo
3. Upright/tower silo
4. Plastic bag
5. 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.

Silage

Even distribution of silage within the silo to exclude air is an important part of making good quality silage. Lactic acid is the most desirable acid produced during ensiling. Butyric acid is an undesirable acid.

Valuable nutrients that can be lost in seepage from a silo are:
1. Minerals
2. Organic acids
3. Protein
4. Soluble sugars

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 33% dry matter. Cold flow ammonia is often added to corn silage to increase the crude protein content. Kernel processing of corn silage is used to increase starch digestibility.

The theoretical length of cut (TLC) for corn silage harvested with a conventional harvester is recommended to be 3/8 inch. If harvested with a harvester fitted with a kernel processor, the TLC should be 3/4 inch.

Corn varieties

Characteristics of corn that have been introduced through transgenics include:
1. Corn borer resistance
2. Herbicide resistance
3. High oil content
4. 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 raise fiber digestibility.

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 or palatability and to 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.
**Miscellaneous**

- **Peak milk production** usually occurs 2-3 weeks before peak feed intake.
- **Positive energy balance** occurs when the amount of energy taken into the body is greater 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.
Chapter 7: Lactation and Milking Management

2011 Virginia 4-H Dairy Quiz Bowl Study Materials

Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BST</td>
<td>bovine somatotropin</td>
</tr>
<tr>
<td>BTMC</td>
<td>bulk tank milk culture</td>
</tr>
<tr>
<td>BTSCC</td>
<td>bulk tank somatic cell count</td>
</tr>
<tr>
<td>CFM</td>
<td>cubic feet per minute</td>
</tr>
<tr>
<td>CIP</td>
<td>clean in place</td>
</tr>
<tr>
<td>CMT</td>
<td>California mastitis test</td>
</tr>
<tr>
<td>CNS</td>
<td>coagulase-negative staphylococcus</td>
</tr>
<tr>
<td>DMSCC</td>
<td>direct microscopic somatic cell count</td>
</tr>
<tr>
<td>IGF</td>
<td>insulin-like growth factor</td>
</tr>
<tr>
<td>IMI</td>
<td>intramammary infection</td>
</tr>
</tbody>
</table>

Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCC</td>
<td>somatic cell count</td>
</tr>
<tr>
<td>SCS</td>
<td>somatic cell score</td>
</tr>
<tr>
<td>WMT</td>
<td>Wisconsin mastitis test</td>
</tr>
</tbody>
</table>

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:

1. Teat cistern
2. Sphincter muscle
3. Streak canal or teat canal (opening in the end of the teat)

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.

Milk production

Lactation is the period of time when a cow is in milk. Cows will normally produce 8 to 15 percent more milk when milked three times a day as compared to those milked twice a day. Three hundred and five day milk production is highest for cows calving in November, December, and January.

Hormones

Adrenaline (epinephrine) can interfere with milk ejection when a cow becomes frightened or upset. Oxytocin is the hormone that causes milk let-down. It is produced by the hypothalamus, but secreted from the posterior pituitary. Maximum oxytocin concentration in blood occurs one minute after beginning of 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.
**Types of milking parlors**

- Herringbone (most common type in use today)
- Parabone
- Parallel
- Rotary
- Side opening

**Parts of a milking unit**
- Teat cup shell
- Milk tube
- Short air tube
- Claw

**Teat cup liners (inflations)** should be replaced every 1,000 – 1,200 cow milkings. Specifically, the only part of the milking system that touches the cow is the teat cup liner or inflation.

**Types of milking systems**

- 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 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.
- 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** is a mechanical or pneumatic means, provided with the bulk milk tank, for stirring the milk to facilitate 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 **requirements for adequate, effective cleaning** of milking systems are:

1. **Time**
2. **Temperature**
3. **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.

---

Cleaning equipment

**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 the 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.

---

Signs of a malfunctioning milking system

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

*A **liner slip** is a condition whereby a teat cup slides down the surface of the teat, often accompanied by a squawk, caused by improper liner design, cluster weight, vacuum fluctuations, or milking wet teats.

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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. The first streams of milk stripped from the udder prior to milking are called **foremilk**.

The process through which milk is squeezed out of milk-producing tissue by the action of the hormone, oxytocin, is called **let-down**.

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

**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.

---

Recommended milking procedures

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

---

Consequences of long pre-milking stimulation

- **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:

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

**Mastitis**

*Mastitis* is the most costly disease in dairy cattle.

*Mastitis-related costs* include:

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

**Mastitis definitions**

*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.

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

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

**Types of mastitis**

The main types of mastitis are described below.

1. **Subclinical mastitis** is mastitis with no detectable change in the udder itself and no observable abnormality of the milk.
2. **Clinical mastitis** is characterized by visible abnormalities in the udder or milk.
3. **Acute mastitis** is characterized by sudden onset, redness, swelling, hardness, pain, grossly abnormal milk, and reduced milk yield.
4. **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**

- Flakes
- Clots
- Presence of blood
- Stringy milk
- Watery milk
- Swollen quarter
- Hot quarter
On-farm screening tests to detect mastitis

- California Mastitis Test (CMT)
- Conductivity
- Strip Cup

Somatic cells

High numbers of somatic cells in milk are generally an indicator of infection, or 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.

Causes of mastitis infections

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

Mastitis-causing pathogens

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 are those growing in the cow’s environment that contact the udder and teats causing infection. Examples include:
- Escherichia coli (E. coli)
- Enterobacter species
- Klebsiella species
- Steptococcus dysgalactiae (Strep. dysgalactiae)
- Steptococcus uberis (Strep. uberis)

Other mastitis-causing pathogens

- Arcanobacterium pyogenes
- Bacillus cereus
- Coagulase-positive staphylococci
- Corynebacterium bovis
- Fungi
- Norcardia species
- Prototheca
- Pseudomonas aeruginosa
- Serratia
- Yeast

Sources of environmental bacteria in dairy herds

- Water
- Soil
- Bedding
- Mud
- Feedstuffs
- Feces
- Mud
Factors affecting the dairy cow’s environment

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

Five steps in a good mastitis control program

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

Mastitis prevention

The most effective measures to prevent new mastitis infections are:

1. Teat dipping
2. Dry cow antibiotic treatment

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

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

Milk quality

The legal limits for somatic cell counts in raw milk are:
United States = 750,000 cells/ml
European Community = 400,000 cells/ml

Legal limit for bacteria counts in raw milk (U.S.) = 100,000 cfu/ml

Sources of on-farm milk contamination include:

1. Air (dust)
2. Antibiotics
3. Dirt (from outside of the cow)
4. Equipment
5. Feed
6. Insects
7. Interior of udder
8. Water

Factors that can influence milk composition

1. Age of cow
2. Environmental temperature
3. Genetics
4. Nutrition
5. Somatic cell count
6. Breed
7. Estrus
8. Milking procedures
9. Season
10. Stage of lactation

Conditions that will cause a decrease in fat test

1. Cow is in heat
2. Extremely hot weather
3. Illness
4. Low fiber content in ration
5. Finely chopped feeds
**Mastitis effects on milk composition**

**Components that decrease in concentration in mastitic milk**
1. Lactose
2. Total proteins
3. Casein
4. Solids not fat
5. Total solids
6. Fat
7. Calcium
8. Phosphorus
9. Potassium

**Components that increase in concentration in mastitic milk**
1. Lipase
2. Sodium
3. Chloride
4. Immunoglobulins
5. Leukocytes
6. 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:**
1. To remove existing infection
2. To prevent new infection

**Reasons to treat every quarter of every cow at drying off are:**
1. Higher concentration of antibiotics (than lactating products)
2. Antibiotics remain longer
3. No discarding of saleable milk
4. Prevents new infections
Chapter 8: Dairy Products and Milk Marketing

2011 Virginia 4-H Dairy Quiz Bowl Study Materials

Acronyms

- ADV: acid degree value
- CFU: colony forming units
- CLA: conjugated linoleic acid
- COOL: country of origin labeling
- CWT: Cooperatives Working Together
- DEIP: Dairy Export Incentive Program
- DIPP: Dairy Indemnity Payment Program
- GATT: General Agreement on Tariffs and Trade
- HACCP: hazard analysis critical control points
- HTST: high temperature, short time
- MILC: Milk Income Loss Contract

Milk

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 used to produce milk for human consumption throughout the world. These animals include:

- Goat
- Sheep
- Camel
- Water buffalo
- Reindeer
- Horse
- Yak

Cow’s milk composition

The components of the solids-not-fat portion of milk are:

- Protein
- Lactose
- Minerals

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

As the protein level in milk increases, milk taste improves.
Lactose

Lactose is the major solids component of milk. It is the milk sugar that gives milk its sweet flavor.

The two simple sugars that make up lactose are:
① Glucose
② 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.

Conjugated linoleic acid (CLA)

Conjugated linoleic acid (CLA) is an 18-carbon fatty acid present in milk, particularly from cows grazing pastures, that has been found to have anticarcinogenic effects.

CLA content is greater in higher fat products.

Advantages of high quality milk

Processor's point of view
① Improved flavor
② Long shelf life
③ Increased cheese yield
④ Reduced hauling and handling costs due to low quality milk not having to be diverted to an alternative use

Dairy producer's point of view
① Greater profitability
② Increased milk yield
③ Larger milk checks due to improved milk per cow and premiums
④ Reduced labor and labor cost
⑤ Low culling rates
⑥ Low treatment costs

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:
① Calcium
② Phosphorus

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.

There is a direct relationship between the quality of milk produced on the farm and that sold off the store shelf.

Milk quality tests

Tests that milk plants use to determine quality of raw milk include:
① Acid degree value
② Antibiotic test
③ Flavor
④ Freezing point
⑤ Leukocyte (somatic cell) count
⑥ Preliminary incubation (PI) count
⑦ Sediment test
⑧ Standard plate count
Milk quality tests

Acid degree value detects rancidity.

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

The cryoscope is the 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 in milk

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

Exposing milk to sunlight or copper bearing surfaces will result in an oxidized flavor. Pigmented milk cartons are used to prevent an oxidized flavor.

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

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

Common off-flavors

1. Bitter
2. Fermented
3. Fruity
4. High acid
5. Lacks freshness
6. Oxidized
7. Rancid
8. Sour

Antibiotics

Antibiotics 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 suitable for cheese making.
- Bacteria may become resistant to antibiotics.
- Antibiotics are not a natural part of milk.

Milk processing

The main purpose of clarification is to remove impurities from milk.

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 in which vitamins are added to milk.

More on pasteurization

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

It increases the shelf-life of milk by substantially reducing the total bacteria population.

It destroys lipase and other natural milk enzymes, which might cause off-flavor in milk during refrigerated storage.

Pasteurization methods

1. High temperature, short-time method
   161°F for 15 seconds
2. Batch or holding method
   145°F for not less than 30 minutes

Milk labeling

<table>
<thead>
<tr>
<th>Milk 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>Fat free, nonfat, or 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>
</tr>
</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. In the U.S. the highest grade of butter sold is U.S. Grade AA.

Butter equivalency
1 stick = 1/2 cup = 1/4 pound = 8 tablespoons

Cheese

It takes 10 pounds of whole milk to make a pound of cheese. The amount of cheese one can get from a pound of milk is most affected by the protein content of the milk.

Rennin is the enzyme obtained from the lining of a calf’s stomach that is used to coagulate casein protein when making cheese.

Rennet is an enzyme used to coagulate milk when making cheese.

Whey is the fluid by-product of cheese making. The three major components of dried whey are lactose, minerals, and protein.

Cream

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

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

Frozen dairy products

Frozen dairy products include:
- Ice cream
- Frozen custard
- Sherbet
- 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

Examples of cultured dairy products include:
- Yogurt
- Buttermilk
- Acidophilus milk

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.

Danone is the world's largest yogurt maker.
Federal Milk Marketing Orders

The Agricultural Marketing Agreement Act of 1937 provided for Federal Milk Marketing Orders. Federal Milk Marketing Orders are regulated by the Secretary of Agriculture. They specify minimum prices and conditions under which regulated milk handlers must operate when selling fluid milk products within a specified geographic area. There are 10 Federal Milk Marketing Orders in the United States. Component pricing is used in 6 of the orders.

Federal Milk Marketing Orders Component Pricing

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>$1.00</td>
</tr>
<tr>
<td>Grade II</td>
<td>$1.20</td>
</tr>
<tr>
<td>Grade III</td>
<td>$1.40</td>
</tr>
<tr>
<td>Grade IV</td>
<td>$1.60</td>
</tr>
<tr>
<td>Grade V</td>
<td>$1.80</td>
</tr>
<tr>
<td>Grade VI</td>
<td>$2.00</td>
</tr>
</tbody>
</table>

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
  - Yogurts
  - Perishable manufactured products (ice cream, cottage cheese, and others)
- **Class III**: Cream cheese
  - Hard manufactured cheese
- **Class IV**: Butter
  - 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.

Other 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** generally refers to the producers of cheese, butter, nonfat dry milk, and other storable dairy products.
- **Processors** generally refers to firms that process raw Grade A milk into fluid products.

Organic dairy production

Organic dairy production is a method of production using cattle cared with:
- No hormones to promote growth
- No antibiotics
- 100% organic feed
- No mammalian or poultry by-products in feed

National Organic Program (NOP)

USDA’s National Organic Program 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
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, and all deductions such as promotion, hauling, capital retains, and cooperative dues.

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.

Top milk producing cooperatives

The **top five milk producing cooperatives** in the U.S. based on member milk volume in 2009 were:

1. Dairy Farmers of America
2. California Dairies, Inc.
3. Land O’Lakes, Inc.
4. Northwest Dairy Association
5. Dairylea Cooperative, Inc.

The top 50 cooperatives accounted for 79.6% of the milk produced in the U.S. in 2009.

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.
- April is National Grilled Cheese Month.
- July is National Ice Cream Month.
- 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.
- According to Dairy Management, Inc., one out of every four pounds of cheese is eaten as part of a sandwich.

Government programs

The **Dairy Export Incentive Program (DEIP)** is a program that provides cash bonuses (subsidies) to exporters of U.S. dairy products to sell certain dairy products in targeted overseas markets.

- The **Milk Income Loss Contract (MILC)** program financially compensates dairy producers when domestic milk prices fall below a specified level. MILC is based on the milk price in **Boston**. The program is administered by the **Farm Service Agency (FSA)**.
Cooperatives Working Together (CWT)

CWT is a dairy farmer-funded self-help program to address supply and demand imbalances that can depress milk prices.

CWT programs include:
1. Export assistance
2. Herd retirement

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

CWT’s funding comes from farmers who invest 10 cents per hundredweight of milk sold.
Chapter 9: Miscellaneous

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Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTAP</td>
<td>Current Testday Analysis Program</td>
</tr>
<tr>
<td>DCR</td>
<td>data collection rating</td>
</tr>
<tr>
<td>DIM</td>
<td>days in milk</td>
</tr>
<tr>
<td>ECM</td>
<td>energy corrected milk</td>
</tr>
<tr>
<td>ERPA</td>
<td>estimated relative producing ability</td>
</tr>
<tr>
<td>FCM</td>
<td>fat corrected milk</td>
</tr>
<tr>
<td>ME</td>
<td>mature equivalent</td>
</tr>
<tr>
<td>PCDART</td>
<td>Personal Computer Direct Access to Records by Telephone</td>
</tr>
</tbody>
</table>

Weights and measures

<table>
<thead>
<tr>
<th>Item</th>
<th>Weighs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A gallon of milk</td>
<td>8.6 pounds</td>
</tr>
<tr>
<td>A quart of milk</td>
<td>2.15 pounds</td>
</tr>
<tr>
<td>A bushel of corn</td>
<td>56 pounds</td>
</tr>
<tr>
<td>A bushel of wheat</td>
<td>60 pounds</td>
</tr>
<tr>
<td>A bushel of barley</td>
<td>48 pounds</td>
</tr>
<tr>
<td>A bushel of oats</td>
<td>32 pounds</td>
</tr>
<tr>
<td>A bushel of soybeans</td>
<td>60 pounds</td>
</tr>
<tr>
<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 - 2009

Number of licensed dairy farms 54,947
Number of dairy cows* 9,201,000
Milk per cow per year 20,576 pounds
Milk production 189 billion pounds

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

State rankings – milk production (2009)

<table>
<thead>
<tr>
<th>Total milk production</th>
<th>Milk per cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>New Mexico</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Washington</td>
</tr>
<tr>
<td>New York</td>
<td>Colorado</td>
</tr>
<tr>
<td>Idaho</td>
<td>Arizona</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>Michigan</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of dairy cows</th>
<th>Milk per person</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>Idaho</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Wisconsin</td>
</tr>
<tr>
<td>New York</td>
<td>New Mexico</td>
</tr>
<tr>
<td>Idaho</td>
<td>South Dakota</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
</tr>
</tbody>
</table>
State rankings – forage production (2009)

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

Corn silage production
1. Wisconsin
2. California
3. New York
4. Pennsylvania
5. Minnesota

DHIA records

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 stands for milked three times a day.

A DHIA record may be terminated if a cow has:
1. Dried off;
2. Aborted; or
3. Died

DHIA records

A lactation record is generally adjusted for the following:
1. Lactation length
2. Mature equivalent
3. 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. It was developed by USDA-AIPL.

Culling

Reasons for culling a dairy cow from the herd include:
1. Low production
2. Mastitis
3. Reproduction
4. Udder
5. Feet and legs
6. Disease
7. Injury

Dairy cattle can be sold privately on the farm or in auction sales. Types of auction sales are:
1. Consignment
2. Dispersal
3. Reduction

2008 Farm Bill

The name of the 2008 Farm Bill is The Food, Conservation and Energy Act of 2008.
The bill made a fundamental change in the milk support purchase program by specifying the support prices of purchased manufactured products, not the price of milk.
Farm business management

The necessary economic inputs for a dairy operation are:

- Land
- Capital
- Labor
- Management

Benchmarking is pinpointing those areas in your business which are going great and those areas where improvements are needed.

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.

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.

Anatomy and physiology

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

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.

Anatomy and physiology

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.

Blood

Approximately 400 pounds of blood are pumped through the udder to produce one pound of milk.

The major artery supplying blood to the udder is the external pudic artery.

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

The ideal temperature range for dairy cattle is 25 to 65°F. A dairy can lose body heat through:

- Convection
- Conduction
- Radiation
- Evaporation

The principles used to cool cows during heat stress include:

- Shade
- Air exchange
- Air movement
- Access to water
- Sprinkle

Photoperiod manipulation

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

Dry cows exposed to a short-day photoperiod (SDPP) produce more milk in the subsequent lactation than similar cows exposed to LDPP or natural light conditions.

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

Animal well-being

According to the AVMA, 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
- **ET**  embryo transfer
- **FSH**  follicle stimulating hormone
- **GnRH**  gonadotropin releasing hormone
- **LH**  luteinizing hormone
- **MOET**  multiple ovulations, embryo transfer
- **PGF2α**  prostaglandin F2α
- **SCR**  sire conception rate

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:
  ① Voluntary waiting period  ② Estrus (heat) detection  ③ Conception rate  ④ Reproductive culling

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:
- ① Age of the cow
- ② Breed of the cow
- ③ Sex of the calf
- ④ Number of calves carried
- ⑤ Season of the year

Brown Swiss have the longest gestation period.

The cow’s reproductive tract

The parts of the cow’s reproductive tract are:
① Vulva
② Vagina
③ Cervix
④ Uterus
⑤ Oviduct
⑥ Ovary

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

Ovaries

The main functions of the ovary are:
- ① Production of ova
- ② Secretion of hormones essential for reproduction

100% of the ova that a mature cow has in her ovaries are present at birth. The fertile life of an ovum after its release from the follicle on an ovary 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

1. **Gonadotropin Releasing Hormone (GnRH)** is secreted by the hypothalamus. It controls the secretion of pituitary hormones (FSH and LH).
2. **Follicle stimulating hormone (FSH)** is secreted by the anterior pituitary gland. It stimulates growth of follicles.
3. **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.

Female reproductive hormones

- **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. Estrumate® and Lutalyse® are commercial prostaglandin products commonly used in dairy cattle reproductive management.

Estrous cycle

The normal range in the length of the estrous cycle is 18 to 24 days. On average, there are 21 days between heat periods in dairy cows.

The estrous cycle contains two phases:
1. Follicular – active follicles are present
2. Luteal – CL is the dominant ovarian structure

The estrous cycle consists of four stages:
1. Estrus – heat period
2. Metestrus – transition
3. Diestrus – CL
4. Proestrus – prior to estrus

Signs of estrus in dairy cattle

1. Restlessness
2. Bellowing
3. Following and smelling another cow
4. Mounting other cows
5. Standing to be mounted*
6. Discharge of clear mucus from the vulva
7. Vulva becomes red and swollen

* The most reliable sign of estrus is standing to be mounted.

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.
- The most common cause of a cow not coming back into heat is pregnancy. 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.

Heat detection aids

1. Heat expectancy charts
2. Tail chalk
3. Pedometers
4. Pressure sensors
5. Electronic heat detection systems
6. Detector animals

Estrus synchronization programs

1. CIDR
2. Ovsynch
3. Pre-Synch
4. Co-Synch
5. Heat-synch
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:

1. Safety
2. Genetic improvement
3. Better disease control
4. Better record keeping
5. Easier to prove bulls
6. Less expensive than keeping a bull

Conception

Reasons for the reduction of conception include:

1. Heat detection failure
2. Hormone imbalance
3. Failure to inseminate
4. Heat detection errors

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2. Genetic improvement
3. Better disease control
4. Better record keeping
5. Easier to prove bulls
6. Less expensive than keeping a bull

Artificial insemination

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

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

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

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

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.

Conception rate

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

1. Heat detection accuracy
2. Herd (cow) fertility
3. Semen (bull) fertility
4. Technician competency

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

1. Failure to ovulate
2. Fertilization failure
3. Hormone imbalance
4. Poor quality semen
5. Failure to inseminate
6. Improper insemination technique
7. Heat detection errors

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3. Hormone imbalance
4. Poor quality semen
5. Failure to inseminate
6. Improper insemination technique
7. Heat detection errors
Pregnancy rate

The reproductive performance of a dairy herd is primarily affected by conception rate and heat detection efficiency. **Pregnancy rate** determines how fast cows become pregnant following the voluntary waiting period (VWP). 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. It 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). Incidence is highest in summer.

Parturition (calving)

**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

Parturition (calving)

The normal birth position of a calf is front feet first with the head between the legs. It usually takes 30 to 45 days after calving for a cow’s reproductive tract to return to normal.

**Involution** is the process where the uterus returns to normal size after calving.

Male reproduction

The **main functions of the testes** are to:

- Produce sperm
- Produce the male sex hormones

**Cryptorchidism** is the condition when the testes fail to descend from the abdomen into the scrotum, often affecting fertility.

The **male reproductive hormones** include:

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

Spermatozoa

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.

The primary sugar found in semen is **fructose**.

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.
Sire Conception Rate

Sire Conception Rate (SCR) is an evaluation of artificial-insemination (AI) service-sire fertility. It replaced Estimated Relative Conception Rate (ERCR). SCR is calculated for Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, and Milking Shorthorn bulls. It is computed by USDA-AIPL.

Ultrasound

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

1. Pregnancy determination
2. Determine embryonic losses
3. Monitor cystic ovaries
4. Determine sex of embryo

Reproductive problems

The number one reason for culling in U.S. dairy herds is reproductive failure.

Metritis 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

An abortion is the premature expulsion of a fetus.

Diseases that cause abortions in dairy cattle include:

1. Brucellosis
2. Campylobacteriosis (Vibriosis)
3. Chlamydia
4. IBR
5. Leptospirosis
6. Listeriosis
7. Neospora
8. Trichomoniasis

Cystic ovaries

12 to 14% of problem breeders have cystic ovaries.
10 to 40% of dairy cows develop cystic ovaries during their lifetime.

Types of cystic ovaries

1. Follicular cysts are thin-walled, anovulatory (not ovulating) cysts; secrete variable amounts of estrogen.
2. Luteal cysts are thick-walled cysts; secrete low levels of progesterone.
3. Cystic corpus lutea have characteristics similar to normal corpora lutea.

Twinning

Disadvantages of twinning in dairy cattle include:

1. Reduced milk production during the lactation
2. Calving difficulties are more frequent
3. Abortion rates are higher
4. Twins are often weak at birth
5. Potential for a freemartin heifer

A freemartin is a sterile heifer born twin to a bull.

Ninety percent of heifers born twin to a bull are sterile.
Chapter 11: Genetics

Acronyms

**AIPL** Animal Improvement Programs Laboratory
**BAA** Breed Average
**BLAD** Bovine Leukocyte Adhesion Deficiency
**BLUP** Best Linear Unbiased Predictor
**CE** Calving Ease
**CM$** Cheese Merit
**CVM** Complex Vertebrae Malformation
**DBH** Difficult Birth in Heifers
**DCE** Daughter Calving Ease
**DNA** Deoxynucleic Acid

Acronyms

**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

Acronyms

**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)
**PTA** Predicted Transmitting Ability
**PTI** Production-Type Index (Ayrshire, Guernsey)

Acronyms

**RFID** Radio Frequency Identification
**RNA** Ribonucleic Acid
**rRNA** Ribosomal Ribonucleic Acid
**RT** Recessive Tested
**RVC** Retrovaginal Constriction (Jersey)
**SB** Stillbirth
**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 county code for the U.S. is **840**.

The most important feature when selecting tags or brands for identification is visibility.
NAAB Code

The NAAB code for a sire has three parts. The number before the letter indicates the stud from which the bull's semen can be purchased. The letters indicate the breed. The number following the letters is an individual bull identification number.

<table>
<thead>
<tr>
<th>Bull Stud</th>
<th>Stud Code</th>
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<tbody>
<tr>
<td>Genex/CRI</td>
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<tr>
<td>Select Sires</td>
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<tr>
<td>Alta Genetics</td>
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<tr>
<td>Accelerated Genetics</td>
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<tr>
<td>ABS Global, Inc.</td>
<td>29</td>
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<table>
<thead>
<tr>
<th>Breed</th>
<th>Letters</th>
</tr>
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<tbody>
<tr>
<td>Ayshire</td>
<td>AY</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>BS</td>
</tr>
<tr>
<td>Guernsey</td>
<td>GU</td>
</tr>
<tr>
<td>Holstein</td>
<td>HO</td>
</tr>
<tr>
<td>Jersey</td>
<td>JE</td>
</tr>
<tr>
<td>Milking Shorthorn</td>
<td>MS</td>
</tr>
<tr>
<td>Red &amp; White</td>
<td>WW</td>
</tr>
</tbody>
</table>

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.

More basic genetics

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
- 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.
Siblings is the technical term used to describe brothers and sisters.

Animal Model

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

When making its evaluation, the Animal Model uses information from:
- Parents (pedigree)
- Individual performance
- Progeny (offspring)
Genetic evaluations

USDA-AIPL publishes genetic evaluations. Official evaluations in 2011 will be released in April, August and December. Genomic evaluations in 2011 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 USDA-AIPL genetic evaluations is updated every five years. It was updated in January 2010 and will be the average PTA of the 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.

Lifetime Net Merit (NM$)

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)

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

Holstein composite indexes

<table>
<thead>
<tr>
<th>Composite Index</th>
<th>Traits Included</th>
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<tbody>
<tr>
<td>Udder</td>
<td>Fore udder attachment Rear udder height Rear udder width Udder depth Udder cleft Front teat placement</td>
</tr>
<tr>
<td>Body Size</td>
<td>Stature Strength Body depth Body depth Thurl width</td>
</tr>
<tr>
<td>Feet &amp; Legs</td>
<td>Rear legs – side view Rear legs – rear view Foot angle Feet &amp; legs score</td>
</tr>
<tr>
<td>Dairy Capacity</td>
<td>Dairy form Dairy strength</td>
</tr>
</tbody>
</table>

Jersey Performance Index (JPI)

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
- Udder Composite
- Feet and Leg Composite
- Productive Life
- PTA Somatic Cell Score
- Functional Udder Index*

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

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

Final classification scores

<table>
<thead>
<tr>
<th></th>
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<th>Jersey</th>
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<tbody>
<tr>
<td>Excellent</td>
<td>90 to 97</td>
<td>Excellent 90 to 100</td>
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<tr>
<td>Very Good</td>
<td>85 to 89</td>
<td>Very Good 80 to 89</td>
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<tr>
<td>Good</td>
<td>80 to 84</td>
<td>Desirable 70 to 79</td>
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<tr>
<td>Good</td>
<td>75 to 79</td>
<td>Acceptable 60 to 69</td>
</tr>
<tr>
<td>Fair</td>
<td>65 to 74</td>
<td>Poor 50 to 59</td>
</tr>
<tr>
<td>Poor</td>
<td>50 to 64</td>
<td></td>
</tr>
</tbody>
</table>
Calving ease

Calving Ease Summaries are calculated by USDA-AIPL for the National Association of Animal Breeders (NAAB). Two summaries are now calculated:

**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.

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

Stillbirth (SB)

**Stillbirth scores**
1 = the calf was born alive and was alive 48 h postpartum
2 = the calf was born dead
3 = the calf was born alive but died within 48 h postpartum

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

**Service Sire SB** measures the tendency of calves from a particular service sire to be stillborn more or less often.

The SB 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
- Mature size is smaller
- More recessive genes exposed
- Slower growth rate

Undesirable recessive traits

- Bovine Leukocyte Adhesion Deficiency (BLAD)
- Bulldog
- Complex Vertebral Malformations (CVM)
- DUMPS
- Dwarfism
- Hairless
- Imperfect Skin
- Mule-Foot (Syndactylism)
- Pink Tooth (Porphyria)
- Prolonged Gestation

Undesirable recessive traits have not been documented for Ayrshires, Guernseys, or Milking Shorthorn.
Chapter 12: Health

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

Normal stats for dairy animals

Temperatures

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

Disease basics

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.

An animal that is infected with a disease but has no clinical symptoms is called a carrier.

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

Disease classification

Diseases can be classified on the basis of their primary cause.
**Infectious diseases**

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

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

**Diseases in dairy cattle that are caused by a virus**

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

**Diseases caused by a clostridial organism**

- Blackleg
- Malignant edema
- Overtreating disease
- Tetanus

**Metabolic diseases**

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

**Diseases with a color in their name**

- **Blackleg**
- **Blue tongue**
- **Pinkeye**
- **Red nose**

- **Red water**
- **White heifer disease**
- **White muscle disease**

**Proper and common disease names**

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

**Bloat**

Bloat is the condition when a cow cannot belch. It may occur in cows grazing rapidly growing legumes.

Carbon dioxide and methane are two gases associated with the condition of bloat.

Poloxolene may be administered to prevent or correct bloat.

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

Bovine Leukosis Virus (BLV) is a retrovirus that infects dairy and beef cattle's lymphoid tissue. The virus is transmitted to cattle primarily by direct exposure with infected blood, saliva, semen, and milk.

Signs of infection may 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 bacteria 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. It can be contracted by drinking raw milk contaminated by brucellosis.

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:
- Watery scours with flakes of blood
- Dull listlessness
- Mucus in the feces
- Dehydration
- Weight loss
- Proximal diaphragmatic weakness
- Eyeballs protruding
- Liver enlargement
- Enlarged lymph nodes
- Enlarged gall bladder

Methods to control coccidiosis:
- Accurate diagnosis and monitoring
- Maintain sanitation
- Limit stress
- Medicate

There are two classes of anti-coccidial drugs. Coccidiostats 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.

Cryptosporidium

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 diarrhea in newborns due to cryptosporidium, as well as other pathogens include:
- Provide clean, dry areas for cows to calve
- Feed colostrum using a clean bottle and sanitized nipple
- Provide clean, dry pens for calves
- Allow pens to thoroughly dry between calves
- Feed and care for sick calves last

Displaced abomasum

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

80 to 90% of displaced abomasums are left-sided.

Predisposing factors for a cow’s displaced abomasum include:
- Stress of calving or high milk production
- Lead feeding
- Acidotic rations
- Hypocalcemia
- Selenium deficiency
- Lack of exercise
- Advanced pregnancy

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:
- Milk fever
- Displaced abomasum
- Retained placenta
- Metritis
- Mastitis
- Fatty liver syndrome
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 unthriftiness
- Soft swelling in the jaw
- Substantial drops in milk production
- Susceptibility to other problems such as infertility
- Weight loss
- Death

Testing for Johne’s disease

There are two types of tests for Johne’s disease commonly used today:
1. Tests that measure antibodies in blood serum
2. Tests that find the organism causing Johne’s disease, *Mycobacterium paratuberculosis*, in manure by fecal culture or 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

1. Prevent highly susceptible newborn calves and young animals from ingesting manure from adults, whether from the dam, the environment, or feed and water.
2. Calving areas should be dry, free of manure, and well bedded.
3. Remove the calf from the dam immediately after birth.
4. Do not use the same equipment to clean up manure and to load feed.
5. Do not walk in feed bunks.
6. Identify and remove infected animals and their manure.
7. Investigate all animals considered for purchase, and buy only from test-negative herds with no history of Johne’s.
8. Do not allow test-positive cows to calve.
9. Sell at birth all calves from positive cows.

Ketosis

*Ketosis* (Acetonemia) is a condition in dairy cattle when there is an accumulation of ketones in the body.

The first signs of ketosis are:
1. Cow goes off feed
2. Ketone (acetone) smell on the cow’s breath

*Propylene glycol* is fed or administered to cows to prevent 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
- Foot baths

Foot baths

The purposes of a foot bath are:
1. Remove irritants from the foot and between the toes
2. Disinfect and cleanse the foot
3. Dry and toughen the foot

Substances commonly used in a foot bath include:
- Copper sulfate
- Zinc sulfate
- Formalin

Milk fever

*Milk fever* is also referred to as hypocalcemia.

A deficiency of blood calcium related to an imbalance of calcium, phosphorus, and Vitamin D is the cause of milk fever.

Most cases of milk fever occur within 72 hours after calving.

About 6 percent of dairy cows are affected by milk fever each year.
**Milk fever**

Groups of cows that are at greater risk of having milk fever are:

1. Older cows
2. Fatty liver cows
3. Jerseys

Symptoms of milk fever include:

1. Cow goes down
2. Rapid heart rate
3. Dilated eyes
4. Below normal body temperature

Calcium glutamate is an intravenous (IV) injection for immediate and temporary treatment of milk fever.

**Mycotoxins**

A mycotoxin is a toxin produced by a fungus, especially a mold.

Clinical symptoms of mycotoxins in dairy cattle include:

- Abortions
- Cystic ovaries
- Infertility
- Feed refusal
- Gastrointestinal upsets
- Poor response to therapy
- Feed refusal due to liver malfunction
- No milk
- Silent heats
- Unthriftiness
- Weight loss

**External parasites**

External parasites in dairy cattle include:

1. Flies
2. Lice
3. Mites
4. Mosquitoes
5. Ticks

Lice are most troublesome during winter and spring.

**Flies**

Types of flies commonly found around the dairy farm:

1. House fly
2. Stable fly
3. Face fly
4. Horn fly
5. Heel fly
6. 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.

Sanitation is the most effective management tool to control flies on a dairy farm.

**Internal parasites**

Internal parasites in dairy cattle include:

1. Lung worms
2. Round worms
3. Stomach worms (The brown stomach worm is the most economically detrimental parasite of cattle.)
4. Liver Flukes
5. Coccidia

Anthelmintics are a class of chemicals used to kill internal parasites.

**Pneumonia**

Predisposing causes of pneumonia in calves:

1. Poor ventilation
2. High humidity
3. Dirty pens
4. Drastic temperature changes
5. Poor nutrition
6. Overcrowding
7. Wide range of ages in one pen

Types of organisms that can cause pneumonia:

1. Bacteria
2. Viruses
3. Molds
4. Yeasts
5. Parasites
### Pneumonia-causing organisms

**Pneumonia-causing bacteria**
- Pasteurella multocida
- Mannheimia (Pasteurella) haemolytica
- Haemophilus somnus
- Mycoplasma

**Pneumonia-causing viruses**
- Infectious bovine rhinotracheitis virus (IBR)
- Parainfluenza-3 virus (PI3)
- Bovine viral diarrhea virus (BVDV)
- Bovine respiratory syncytial virus (BRSV)

### Scours

**Scours** is a disease in calves characterized by diarrhea, dehydration, and unthriftness. It is easily transferred from one animal to another through the manure of an infected animal.

**Organisms that commonly cause scours among calves**

**Bacteria**
- Eschericia coli
- Salmonella
- Clostridium perfringens

**Viruses**
- Rotavirus
- Coronavirus

**Protozoa**
- Coccidia
- Cryptosporidium

### Rabies

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:
- Bobcat
- Coyote
- Fox
- Raccoon
- Skunk

### Acidosis

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

### Blackleg

Is an acute, fever producing disease of cattle and sheep. It is caused by the bacterium Clostridium chauvoei. It most often occurs in pastured cattle during the spring or fall.

### Foot rot

Is also known as pododermatitis. A 5% solution of copper sulfate is the most common walk-through treatment.

### Grass tetany

Is a metabolic disorder associated with a magnesium deficiency. It occurs most often in adult cows milking heavily and grazing lush green pastures.

### 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.

### Mad Cow Disease

(Bovine Spongiform Encephalopathy) affects the nervous system. It originated in Great Britain.

**Neosporosis** is a disease that causes abortions and occasionally causes birth of weak “dummy” calves that have serious brain infections. It is caused by a protozoa, Neospora caninum. Dogs are classified as a definitive host for the causative organism.

*Pinkeye* (Keratoconjunctivitis) is most prevalent during the summer. Incidence may be reduced by ensuring that proper levels of Vitamin A are in the diet.

*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.

### Shipping fever

Is a respiratory disease that cattle often develop after being transported by truck or rail.

**Udder edema** is a condition that exists when an excessive amount of lymph accumulates between the skin and secretory tissue of the udder.

**An umbilical hernia** is a condition when a loop of intestine protrudes from the navel.

**Warts** are caused by a virus and are contagious to other calves.

**White muscle disease** is caused by a deficiency of Vitamin E and selenium.
**Morbidity versus mortality**

- **Morbidity rate** is the number of sick animals.
- **Mortality rate** is the number of dead animals.

**Vaccinations**

- **Calvehood vaccinations** should be considered for the following diseases:
  ① IBR  ⑥ Leptospirosis
  ② BVD  ⑦ Clostridia
  ③ PI-3  ⑧ Malignant edema
  ④ Brucellosis  ⑨ Scours
  ⑤ Blackleg

The major types of vaccines are:
  ① Killed
  ② Modified live

**Antibiotics**

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

A cow can be given antibiotics in numerous ways including:
  ① Intramuscular injection (most common)
  ② Intravenous injection
  ③ Intraperitoneal injection
  ④ Intramammary infusion
  ⑤ Intrauterine infusion
  ⑥ In the ration

The **jugular vein** is the ideal location for most intravenous injections.

**Antibodies**

- **Antibodies** (also known as immunoglobulins) are proteins synthesized by organs of the cow’s immune system that aid in the elimination of foreign substances such as microorganisms.

The four main immunoglobulin isotypes are:
  ① IgA
  ② IgE
  ③ IgG
  ④ IgM

**Medicine chest**

Suitable items for the 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.

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

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

**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.

**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
- Cowpox
- Cryptospirosis
- Leptospirosis
- Listeriosis
- Q-fever
- Rabies
- Ringworm
- Salmonellosis
- Tuberculosis
Chapter 13: Nutrient Management

2011 Virginia 4-H Dairy Quiz Bowl Study Materials

Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>BMP</td>
<td>Best Management Practice</td>
</tr>
<tr>
<td>CAFO</td>
<td>Concentrated Animal Feeding Operation</td>
</tr>
<tr>
<td>CNMP</td>
<td>Comprehensive Nutrient Management Plan</td>
</tr>
<tr>
<td>EQIP</td>
<td>Environmental Quality Incentive Program</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated Pest Management</td>
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<tr>
<td>NPS</td>
<td>Non-point Source</td>
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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.

Phosphorus (P) and nitrogen (N) contamination of ground and surface water are the leading environmental issues facing farmers.

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.

Non-point source

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.

Most farms, agricultural cropland, and suburban lawns receiving fertilizer are all examples of nonpoint sources of nutrient pollution.

Best management practices (BMP’s)

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.

BMP’s for livestock farms

- 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
BMP’s for livestock farms

- 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

Methods of reducing soil erosion

- Wind breaks
- Cover crop
- Strip cropping
- Contour cropping
- Terracing
- Grass waterways
- Reduced tillage
- Soil seeding

Common dairy cattle bedding materials

- 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 lb 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

Well-managed alternative water sources usually provide the animals with cleaner water and help prevent exposure to certain diseases.

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.

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.

Manure testing

Benefits of small grain cover crops include:
- Increase use of land applied nutrients
- Stabilize cropland
- Prevent erosion in wintertime

Benefits of manure testing (measuring nutrient content) include:
- May reduce fertilizer purchases.
- May prevent application of nutrients in excess of crop requirements.

Factors that affect the nutritive value of manure are:
- Type of feed ration
- Method of collection
- Method of storage
- Time of application
- Method of application
- Soil characteristics
- Crop
- Climate
- Amount of added feed, bedding, and water
Manure storage

**Manure storage** allows manure to be applied according to crop needs rather than on a daily basis.

**Types of storage facilities**

1. Solid manure storage – dry stack barn
2. Slurry manure storage – anaerobic pit, earthen structure, or above ground tank (most common on dairy farms)
3. Liquid manure storage – lagoon

General categories of **odor-controlling chemicals** for manure management:

- Masking agents
- Odor counteractants
- Enzymatic products

Planning a waste management system

The following factors should be considered when planning a waste management system:

1. Environmental (Rainfall, stream location, prevailing winds, evaporation, temperature, topography, soil type, surface drainage, water table depth)
2. Operational (Herd size, cropping & feeding practices, land area, cropland for waste application, existing buildings & machinery)
3. Economic (Availability of capital and labor, future expansion plans)
4. Social (Neighbors, zoning)
5. Legal Requirements (EPA General Permit, State and local permits)

Composting

**Composting requires:**

1. Air
2. Moisture
3. Nutrients
4. 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:**

1. Reduces volume
2. Doesn’t attract flies and insects
3. Reduces potential for nutrient runoff
4. Weeds and pathogens destroyed
5. More uniform than manure
6. Reduces fertilizer needs
7. Excellent soil conditioner

Fertilizer

Fertilizer labels have three important numbers.

1. The first number is the amount of **nitrogen** (N).
2. The second number is the amount of **phosphate** (P<sub>2</sub>O<sub>5</sub>).
3. The third number is the amount of **potash** (K<sub>2</sub>O).

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.