Dry matter intake: Lactating cows

Dry matter intake (DMI) guidelines for first-lactation heifers and cows of second or greater lactation are in Table 1. First-lactation heifers have a slow, steady rise in DMI during early lactation, reaching a plateau at about 16 weeks and remaining there for the duration of the lactation. In contrast, cows starting their second or later lactations increase DMI rapidly the first few weeks of lactation, peaking at five to six weeks of lactation and then slowly decreasing as lactation progresses.

One challenge when formulating diets for high milk production is that all nutrients required by the cow must be contained in the amount of DM consumed. Therefore, knowing DMI is a critical component in meeting the nutrient requirements of animals. This is because: (1) animals require amounts of nutrients, not percentages or concentrations, each day to maintain health and production and (2) certain nutrients like energy and rumen undegradable protein (RUP) concentrations in the diet are affected by the amount of feed DM an animal consumes.

It is useful to compare actual and predicted DMI. If actual DMI is 5% above predicted DMI, check the following: feeding accuracy (are mixer scales calibrated and the total mixed ration [TMR] properly mixed prior to feeding), feed refusal (is this accounted for and reasonably accurate), is the DM value of feedstuffs correct, are cow bodyweights (BW) accurate and is feed efficiency within the expected range (average 1.4-1.6 lb. of milk per pound of DMI). In contrast, if actual DMI is less than predicted, one of the following may be limiting DMI: ration palatability, feed access, high fiber rations, water intake, heat stress or excess dietary RUP.

The following equation can be used to predict DMI of lactating cows (NRC, 2001) and was used to calculate data in Table 1: DMI (kg/d) = (0.372 × 4% FCM + 0.0968 × BW^{0.75}) × (1-e^{-0.192 × (WOL + 3.62)}); where BW = bodyweight (kg), e = 2.71828, WOL = week of lactation, 4% FCM (fat-corrected milk) = (kg of milk × 0.4) + (kg of milk × fat% ÷ 100 × 15).

Dry matter intake: Dry cows

For dry cows more than 21 days before calving, DMI will be about 2% of bodyweight. For cows less than 21 days before calving, a DMI of 22-24 lb. per day is a good amount to use in formulation of diets. Cows will consume this amount of DM up to within a few days of calving. Also, close-up dry cow groups are very dynamic with cows coming in and out daily making accurate measurements of DMI per cow in this group very difficult.

Energy requirements: Lactating, dry cows

The energy system used for lactating and dry dairy cows is net energy of lactation (NE\textsubscript{L}) and is expressed in megacalories (Mcal). Dairy cows require energy for the following functions: maintenance, lactation, activity, pregnancy and growth (Dairy NRC, 2001).

**Maintenance.** Energy requirements for maintenance are calculated as: NE\textsubscript{L}, Mcal/day = 0.08 × BW^{0.75} (BW = bodyweight in kilograms). Maintenance energy is needed for life’s normal daily processes.

**Lactation.** The energy required to produce milk is based on the total amount of milk produced and the energy content of the milk based on milk components (fat, true protein...
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If you’re not using Posilac® as a productivity tool, you could be losing out on a dollar-per-cow per day competitive advantage. It’s simple math that can make a huge difference for a more robust bottom line. Furthermore, with Posilac, every six of your cows could produce as much as seven non-supplemented cows.* And you deserve every drop of that.

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and lactose). The energy required for milk production can be determined using the following equations: NE\textsubscript{L} (Mcal/kg) = 0.0929 \times \text{fat \%} + 0.0563 \times \text{protein \%} + 0.0395 \times \text{lactose \%; or, if lactose is not known, } NE\textsubscript{L} (Mcal/kg) = 0.0929 \times \text{fat \%} + 0.0563 \times \text{protein \%} + 0.192.

**Activity.** Excessive walking increases maintenance energy requirements by 0.00045 Mcal/kg bodyweight for every kilometer walked. For example, a 600-kg (1,323 lb.) cow that walks 2 km (1.2 miles) per day needs an additional 0.54 Mcal of energy per day or about a 5.5% increase in maintenance requirement. Mild to severe heat stress can increase maintenance energy requirements up to 25%.

**Pregnancy.** Before 190 days of gestation, no additional energy above maintenance is needed for pregnancy. Between 190 and 279 days of gestation, pregnancy requirements of the average Holstein cow increase from 2.5 to 3.7 Mcal per day, respectively.

**Growth and body reserves.** As a general guideline, maintenance energy requirement should be increased 20% for growth of first- and second-lactation cows. Changes in bodyweight during lactation are reflected in body condition score (BCS) change. The energy associated with 1 kg of bodyweight loss from a cow with a BCS of 2 is 3.8 Mcal compared with 5.6 Mcal for a cow with a BCS of 4. Conversely, the energy needed for 1 kg of gain at a BCS of 2 is 4.5 Mcal compared beyond ingredients

At Nutriad we go far beyond just providing feed ingredients. We start by listening to the dairy producer and recognizing their current feed and management program needs. Then our experienced and innovative team develops a targeted solution using our application expertise and “applying nature” approach to optimize user benefit. From Dairy Krave\textsuperscript{a} that provides consistent taste profiles, to Apex\textsuperscript{a} that incorporates known benefits of specific plant extracts or Adi-Flow which minimizes stresses related to production, reproduction and environmental issues, Nutriad delivers. Anyone can provide an ingredient... Nutriad gives you a system of species-specific solutions that are right for today and tomorrow.

---

1. **DMI (lb./day) of first lactation and greater lactation cows**

<table>
<thead>
<tr>
<th>Days in milk</th>
<th>14</th>
<th>23</th>
<th>28</th>
<th>33</th>
<th>37</th>
<th>41</th>
<th>49</th>
<th>54</th>
<th>59</th>
<th>66</th>
<th>75</th>
<th>85</th>
<th>94</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk production (lb./day) – 3.75% fat</td>
<td>30</td>
<td>90</td>
<td>70</td>
<td>90</td>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Energy formulation guidelines

<table>
<thead>
<tr>
<th>Lactating cows – Stage of lactation</th>
<th>Dry cows – Stage of lactation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE\textsubscript{L} Mcal/lb. DMI</td>
<td>0.78–0.80</td>
</tr>
</tbody>
</table>

3. **Fiber and NFC guidelines for lactating and dry cow diets\textsuperscript{1}**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Early</th>
<th>Mid</th>
<th>&gt;200 days</th>
<th>Far-Off</th>
<th>Close-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total NDF</td>
<td>&gt; 28</td>
<td>&gt; 19</td>
<td>&gt; 19</td>
<td>37-44</td>
<td>24-26</td>
</tr>
<tr>
<td>Forage NDF</td>
<td>29-32</td>
<td>20-22</td>
<td>&gt; 19</td>
<td>35-42</td>
<td>23-25</td>
</tr>
<tr>
<td>ADF</td>
<td>&gt; 32</td>
<td>21-24</td>
<td>&gt; 19</td>
<td>35-42</td>
<td>22-25</td>
</tr>
<tr>
<td>NFC\textsuperscript{2}</td>
<td>&gt; 30</td>
<td>&gt; 35</td>
<td>&gt; 25</td>
<td>&lt; 35</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>

\textsuperscript{1}Assumes forage particle size is adequate and ground dry corn is starch source.

\textsuperscript{2}NFC = 100 – (NDF + CP + Fat + Ash).

4. **MP requirements for lactating and dry cows**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maintenance bodyweight, lb.</th>
<th>MP requirement, g/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>404</td>
<td></td>
</tr>
<tr>
<td>1,100</td>
<td>410</td>
<td></td>
</tr>
<tr>
<td>1,200</td>
<td>418</td>
<td></td>
</tr>
<tr>
<td>1,325</td>
<td>423</td>
<td></td>
</tr>
<tr>
<td>1,425</td>
<td>427</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gestation - when &gt; 220 days pregnant</th>
<th>240 g + 2 g/day for every day &gt;220</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactation, true milk protein % g/lb. of milk produced</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>19</td>
</tr>
</tbody>
</table>

5. **Dietary protein guidelines for lactating and dry cows, 1,500 lb. cow**

<table>
<thead>
<tr>
<th>Protein fraction</th>
<th>Lactating cows – Stage of lactation</th>
<th>Dry cows – Stage of lactation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP, % of DM</td>
<td>17–18</td>
<td>16–17</td>
</tr>
<tr>
<td>RDP, % of CP</td>
<td>60–65</td>
<td>64–68</td>
</tr>
</tbody>
</table>
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with 6.2 Mcal for a BCS of 4.

Net energy formulation guidelines for lactating and dry cows are in Table 2.

**Feed, diet energy**

Net energy available from feeds is dependent on the nutrient composition and digestibility of the feed; the degree of physical or chemical processing can have a significant effect on nutrient digestibility of feeds and should be considered when determining feed energy values.

The amount of DM consumed is a major determinant of a diet’s energy concentration and ultimately the amount of energy retained by the animal. As DMI increases, the rate of feed passage through the digestive tract increases, decreasing diet digestibility. Therefore, the same diet will have less energy available to the cow per unit of DM consumed (a lower energy concentration, or NE, per pound) at a high DMI compared to a low DMI. However, the total amount of energy consumed will be greater at the high DMI. This means the energy value of feeds and diets are not constant and change with DMI.

Traditionally, a standard 4% reduction in energy concentration is used for every multiple of DMI above maintenance. For example, a cow eating 45 lb. of DM per day with a 15 lb. of the diet DM required for maintenance is eating at 3X maintenance (45 lb./15 lb.). Intake above maintenance is 2 (3X - 1X for maintenance) and, therefore, the energy value of the diet is decreased 8% over what it would be at only the 15 lb. required for maintenance. Most formulation programs and energy values shown on forage reports use a NE at 3X maintenance.

**Carbohydrates**

The composition of carbohydrate in feeds is important as it determines the volatile fatty acids produced during the digestion or fermentation of feeds in the rumen. Feed carbohydrates are typically classified as either fiber or non-fiber.

Fiber carbohydrates include neutral detergent fiber (NDF) and acid detergent fiber (ADF) and are primarily cellulose and hemicellulose. Forages are the major source of fiber in most dairy diets and during fermentation yield significant amounts of acetic acid and some propionate and butyrate. Fiber carbohydrates (NDF and ADF) are less digestible than starches and sugars and, therefore, have a filling effect and limit the amount of DMI.

The non-fiber carbohydrate (NFC) fraction is considered to be starches and sugars; however, other components such as organic acids and neutral detergent soluble fibers (pectins, beta-glucans, fructans) are included in NFC. The true composition of NFC will variable with type of feedstuff with legume and grass forage’s NFC being predominately pectin, soluble fibers and organic acids compared to corn where almost all of the NFC is starch. The NFC components, with the exception of pectins, ferment to mostly propionic and lactic acids. As these are stronger acids than acetic acid, especially lactic
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6. General mineral guidelines for dry and lactating dairy cows

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Early lactation</th>
<th>Mid to late lactation</th>
<th>Dry cow</th>
<th>Far-off</th>
<th>Close-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>&gt; 0.80</td>
<td>0.65–1.00</td>
<td>0.65–1.00</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td>&gt; 0.40</td>
<td>0.38–0.40</td>
<td>0.36–0.40</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>&gt; 0.30</td>
<td>0.25–0.30</td>
<td>0.30</td>
<td>0.30–0.35</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>&gt; 1.50</td>
<td>1.50</td>
<td>&lt; 1.50</td>
<td>&lt; 1.3</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>&gt; 0.20</td>
<td>&gt; 0.20</td>
<td>0.10</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>0.30</td>
<td>0.30</td>
<td>0.15</td>
<td>&lt; 0.70</td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.20–0.25</td>
<td>0.20–0.25</td>
<td>0.20–0.25</td>
<td>&lt; 0.40</td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>0.35–0.50</td>
<td>0.35–0.50</td>
<td>0.20–0.25</td>
<td>&lt; 0.40</td>
<td></td>
</tr>
<tr>
<td>DCAD – mEq/100g DM</td>
<td>28–56</td>
<td>25–35</td>
<td>25–35</td>
<td>10 to 10</td>
<td></td>
</tr>
</tbody>
</table>

--- Diet DM ppm --- Supplemental ---

- Cobalt 0.50–1.0 0.2–0.50 0.51–1.0 0.52–1.0
- Copper 14–16 12–16 14–16 14–16
- Iodine 0.1–0.9 0.70–0.90 0.9–1.0 0.9–1.0
- Iron 0–0.3 0–0.3 0–0.3 0–0.3
- Manganese 50–70 40–60 50–70 50–70
- Selenium 0.3 0.3 0.3 0.3
- Zinc 75–85 55–75 75–85 75–85

*Adapted from Zinpro Corp. and Dairy NRC, 2001.

Acid, they will have a much greater impact on decreasing rumen pH than acetic acid. Therefore, the composition of the NFC should be considered in formulation of diets. The NFC content (%) of a feed or diet can be estimated by subtracting the sum of the crude protein (CP; %), fat (%), NDF (%) and ash (%) in a feed or diet from 100 (all compositional values are on a DM basis). However, a better formula corrects for CP in the NDF fraction already included as part of the total CP.

Starch levels of 23-26% of the diet DM are suggested for lactating cows; however, no specific starch requirement has been established. The availability of starch in the rumen will have a significant effect on how much starch can be fed in a diet. Dietary starch content should be lowered when high rumen degradable sources like steam-flaked, very-fine-ground or high-moisture corn are fed compared to coarse ground or cracked dry corn. Recent research indicates lower starch levels (17.5-21.0%) can be fed to lactating dairy cows without decreasing cow performance if the starch source is replaced with highly digestible byproduct feeds (Dann et al., 2008; Rathnathunga et al., 2008).

Sugar is very rapidly fermented in the rumen and, therefore, feeding guidelines are lower than for starch (Table 3). Diets low in ruminally available carbohydrate are most likely to benefit from sugar addition. Sugar concentrations of up to 9% of the DM can be successfully fed in diets with moderate to low starch concentrations (less than 22% of

7. Daily recommended fat soluble vitamin intake for lactating and dry cows (Dairy NRC, 2001; Weiss, 2007)

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Lactating IU/day</th>
<th>Dry IU/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>85,000–100,000</td>
<td>85,000–100,000</td>
</tr>
<tr>
<td>D</td>
<td>20,000–30,000</td>
<td>20,000–30,000</td>
</tr>
<tr>
<td>E</td>
<td>500</td>
<td>1,000*</td>
</tr>
</tbody>
</table>

*Supplementing 2,000–4,000 IU per day may be beneficial 2–3 weeks prior to calving.

AjiPro-L provides an optimal balance between rumen protection and delivering a highly-available source of L-Lysine to the small intestine.

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Ed Gilman, PAS, Central Regional Sales
Nixa, MO 417-849-0745

Mike Maloney, PAS, Western Regional Sales
Petaluma, CA 707-484-5811

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8. Nutrient requirements of growing Holstein heifers at three ages

<table>
<thead>
<tr>
<th>Age, months</th>
<th>6</th>
<th>12</th>
<th>12*</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodyweight, lb.</td>
<td>450</td>
<td>650</td>
<td>650</td>
<td>1,050</td>
</tr>
<tr>
<td>DMI, lb./day</td>
<td>11.6</td>
<td>15.4</td>
<td>17.2</td>
<td>26.7</td>
</tr>
<tr>
<td>ME required, Mcal/day</td>
<td>10.8</td>
<td>17.0</td>
<td>25.2</td>
<td>22.4</td>
</tr>
<tr>
<td>MP required, lb./day</td>
<td>0.92</td>
<td>1.25</td>
<td>1.30</td>
<td>1.52</td>
</tr>
<tr>
<td>Target gain, lb./day</td>
<td>1.41</td>
<td>2.09</td>
<td>2.09</td>
<td>1.51</td>
</tr>
<tr>
<td>ME allowable gain, lb./day</td>
<td>1.62</td>
<td>1.84</td>
<td>0.05</td>
<td>2.32</td>
</tr>
<tr>
<td>MP allowable gain, lb./day</td>
<td>1.55</td>
<td>1.93</td>
<td>1.96</td>
<td>3.46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diet ingredients (lb. DM/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haylage</td>
</tr>
<tr>
<td>Corn silage</td>
</tr>
<tr>
<td>Soybean meal-44%</td>
</tr>
<tr>
<td>Dical–18% P</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diet nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP, %</td>
</tr>
<tr>
<td>RDP, %</td>
</tr>
<tr>
<td>CP, %</td>
</tr>
<tr>
<td>ME, Mcal/lb.</td>
</tr>
<tr>
<td>Calcium – total %</td>
</tr>
<tr>
<td>Absorbed supplied, g</td>
</tr>
<tr>
<td>Phosphorus, total %</td>
</tr>
<tr>
<td>Absorbed supplied, g</td>
</tr>
<tr>
<td>Absorbed required, g</td>
</tr>
</tbody>
</table>

*Heifer raised in an environment of 20°F, wind of 15 mph with a wet and muddy hair coat.

Nutrition & Health - Dietary Allowances for Dairy Cattle

DM). Fiber and NFC guidelines for lactating and dry cow diets are shown in Table 3. The amount of NDF from forages, total NDF and ADF recommendations should be considered minimum guidelines, whereas NFC recommendations should be considered as maximum guidelines. Other dietary factors including grain source, rumen availability of starch, fiber source, fiber particle size and digestibility of fiber should be considered when choosing the amount of fiber and NFC feedstuffs to include in the diet. When formulating diets, use NDF as the measurement for fiber content of the diet; as total NDF in the diet decreases a higher percentage of NFC should come from forages and the total NFC in the diet should decrease.

Forage particle size. The NDF content of a diet does not reflect the amount of physically effective fiber (peNDF) in the diet. The peNDF represents the longer fiber particles that stimulate cud chewing and are used to maintain the rumen mat, an essential component for rumen function and animal health. Forages are the major source of peNDF. Several research studies have indicated a minimum forage particle length of 6.5 mm (0.25 in.) is needed to maintain good rumen pH and adequate rumination activity and prevent depressions in milk fat percentage (Allen, 1997; Beauchemin et al., 1994; Grant et al., 1990). The Penn State particle box is an excellent tool for estimating particle size in forages and TMRs. Guidelines for TMR particle size using the Penn State box are: top screen = 6-10%, second screen = 40-50%, third screen < 35% and bottom pan < 20% of the total sample wet weight.

NDF digestibility is an estimation of what proportion of NDF is digested in the rumen during a given time period. Current Ohio research has shown there is not a strong relationship between the NDF digestibility of the forage in a diet and the overall diet digestibility. Differences in forages and diets along with the variability in NDF digestibility analysis prob-

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ably require forages to have an 8% unit difference or more in NDF digestibility before changes in production are observed on farms (Oba and Allen, 1999). However, NDF digestibility is a valid measure to index forage quality differences within forages species.

Fat: Lactating cows

The total fat in lactating dairy cow diets should be limited to 6% of the diet DM. The fatty acid content of most forages and grains ranges from 2% to 4% of DM. Thus, the guideline for supplemental fat feeding is up to a maximum of 2% of the total diet DM. However, total fat is a gross approach to fat feeding for energy as the composition of the fat, especially the unsaturated fatty acid content, can affect production responses such as milk fat depression and reproduction.

Important fatty acids in the diet are: oleic (C18:1), linoleic (C18:2) and linolenic (C18:3). However, the amount of these acids and/or total polyunsaturated fatty acids (PUFA) in diets to avoid milk fat depression or enhance reproduction is uncertain at this time.

Protein: Lactating and dry cows

The protein requirement of dairy cows is met from feed, rumen microbes (microbial protein produced from fermentation of feeds in the rumen) and, to a lesser degree, endogenous protein. The protein in feed is either degraded in the rumen, which is referred to as rumen degraded protein (RDP), to support fermentation of feedstuffs and microbial protein growth, or it is undegraded (RUP) and “bypasses” rumen fermentation. The RUP concentration of a diet is dynamic and increases as DMI increases because faster diet passage rates through the rumen which reduces time for rumen degradation of protein.

In the rumen, degradable dietary proteins are degraded to ammonia and peptides. Between 50% and 95% of dietary protein is degraded in the rumen. With a good carbohydrate balance, most of the protein degraded will be captured by rumen microbes and be converted into microbial protein.

In the small intestine, RUP, microbial protein and endogenous protein are digested to amino acids. The amino acids absorbed from the intestine are referred to as metabolizable protein (MP). The MP requirements for lactating and dry cows are in Table 4 and the dietary CP and RUP recommendations are provided in Table 5 (NRC, 2001).

Amino acids. Cows require amino acids to meet their metabolic and production “protein” requirements. Due to the complexity of both feed protein digestion in the rumen and the production of microbial protein during rumen fermentation, absolute amino acid requirements have not been definitively established. However, based on dose-response curves, recommended levels for lysine and methionine in lactating dairy cow diets are 6.6-6.8% and 2.2% of the MP or a 3:1 ratio, respectively (Schwab and Boucher, 2007). Other amino acids can be limiting such as histidine, leucine and valine, but definitive requirements or levels in the diet for maximum production are not known.

Minerals

Mineral guidelines for lactating and dry dairy cows. The absorbed mineral is the amount of mineral that is needed to meet tissue and production requirements. Not all minerals in the diet are absorbed equally, and absorbability of individual minerals from feedstuffs depends on the mineral concentration in a feedstuff, type of feedstuff and interactions with other minerals and nutrients. The minimum recommended dietary concentration of minerals needed to meet the absorbed amounts in standard diets is shown in Table 6.

DCAD. Dietary cation-anion difference (DCAD) is a measure of the difference between the concentration of strong cations (positively charged ions) and anions (negatively charged ions) in the diet. A variety of equations have been proposed to determine DCAD, but the commonly utilized equation is: DCAD mEq (milliequivalents)/100 g dietary DM = [(%sodium x 43.5 + %potassium x 25.6) - (%chloride x 28.2 + %sulfur x 62.5)]. Negative DCAD diets can be fed to close-up dry cows as a method to decrease metabolic disorders associated with calving. Positive DCAD diets should be fed to lactating dairy cows to promote milk production and health.

Close-up dry cows (less than 3 weeks prior to calving): Recommended DCAD level is -10 to -15 mEq/100 g dietary DM. Negative DCAD diets are fed to help maintain blood calcium levels at or following parturition. Bone is a major source of buffer used to control acid-base balance in the body. When
Nutrition & Health - Dietary Allowances for Dairy Cattle

9. ME and ADP requirements of young calves fed a liquid and/or solid diet.

<table>
<thead>
<tr>
<th>Calf weight, lb.</th>
<th>Daily gain, lb.</th>
<th>DMI, lb.</th>
<th>ME, Mcal/day</th>
<th>ADP, lb./day</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>0.9</td>
<td>0.9</td>
<td>2.0</td>
<td>0.25</td>
</tr>
<tr>
<td>88</td>
<td>0.9</td>
<td>1.2</td>
<td>2.6</td>
<td>0.26</td>
</tr>
<tr>
<td>110</td>
<td>0.9</td>
<td>1.4</td>
<td>3.0</td>
<td>0.26</td>
</tr>
<tr>
<td>88</td>
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<td>2.1</td>
<td>3.9</td>
<td>0.29</td>
</tr>
<tr>
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<td>2.3</td>
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</tr>
<tr>
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<td>5.3</td>
<td>0.53</td>
</tr>
<tr>
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<td>1.5</td>
<td>4.4</td>
<td>6.2</td>
<td>0.56</td>
</tr>
<tr>
<td>220</td>
<td>1.5</td>
<td>5.3</td>
<td>7.0</td>
<td>0.58</td>
</tr>
</tbody>
</table>

10. Impact of temperature on ME requirements of calves

<table>
<thead>
<tr>
<th>Temperature, °F</th>
<th>Increase in ME, % for Calves, birth to 3 weeks</th>
<th>Increase in ME, % for Calves &gt; 3 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
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</tr>
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<td>86</td>
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<td>94</td>
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<td>-4</td>
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<td>108</td>
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<tr>
<td>-13</td>
<td>121</td>
<td>121</td>
</tr>
<tr>
<td>-22</td>
<td>134</td>
<td>134</td>
</tr>
</tbody>
</table>

Lactating dairy cows: To maximize feed intake and milk production, a positive DCAD between 25 and 35 mEq/100 g DM is recommended. Feeding a positive DCAD diet is useful in heat stress conditions as cows under heat stress experience losses of bicarbonate and potassium (Beede, 2005).

Vitamins

Fat-soluble vitamins (A, D, E, K): Recommended dietary intake of fat-soluble vitamins for dry and lactating dairy cows is shown in Table 7. For cows housed in confinement, dietary supplementation of vitamin A, D and E is recommended. As vitamin D is synthesized in the presence of sunlight, vitamin D supplementation may not be necessary when cows are primarily on pasture. Supplementing with vitamin K is not needed due to microbial synthesis of menaquinones (vitamin K2) and the concentration of phylloquinones (vitamin K1) in forages commonly fed to dairy cows.

Water-soluble vitamins (B-vitamins and vitamin C): Dietary supplementation of water-soluble vitamins is not required to prevent clinical deficiencies; vitamin C is synthesized by the cow in the liver and kidneys, most B-vitamins are synthesized by rumen and intestinal bacteria and there is a significant amount of B-vitamins in feeds typically fed to dairy cows. Under certain conditions, however, the addi-
tation of the following water-soluble vitamins to dairy cow di-
ets may result in health and/or performance improvements (Dairy NRC, 2001; Weiss, 2007).

Biotin: Research has shown a positive effect of biotin on hoof health and lameness when dairy cows are supplement-
ed with 20 mg of biotin per day for two to six months. In-
creased milk yields (2-3 lb. per day) also have been reported
with biotin supplementation.

Niacin: Niacin is involved in energy and fat metabolism and
is, therefore, important for the production of milk and milk
components. Supplementation at 12 g per day may slightly
improve milk, protein and fat yield during early lactation.
Feeding rumen unprotected niacin at 6-12 g per day appears
to be ineffective in reducing ketosis. Niacin is extensively
degraded in the rumen and, therefore, if niacin supplementa-
tion is considered, a rumen-protected source would likely be
more beneficial than an unprotected source.

Choline: Choline is rapidly degraded in the rumen if not
encapsulated or protected from rumen microbial degrada-
tion. Rumen-protected choline has been shown to result in
a fairly consistent positive milk yield response (about 5
lb. per day) when supplemented at approximately 30 g per
day. Rumen-protected choline has also been supplemented
in transition cow diets to decrease the incidence of fatty
liver and ketosis.

Impact of minerals and vitamins on immunity. Many trace
minerals and vitamins have important roles in maintaining a
healthy immune system. For example, vitamin E, selenium
and vitamin A serve as antioxidants, decreasing cellular
damage from free radicals in the body. Copper and zinc are
required components of superoxide dismutase, an enzyme
that protects cells from reactive oxygen species formed by
neutrophils in order to destroy pathogens.

Deficiencies of micro minerals, therefore, may impair im-
mune function and affect the cow’s ability to fight off dis-
eases. This would be especially detrimental during the trans-
ition period or during periods of stress when the immune
system is already compromised.

Micro mineral requirements to optimize immune function
are not known. Researchers investigating the relationship
between micro minerals and immune function of dairy cows
have primarily focused on selenium, vitamin E, copper and
zinc (Spears, 2000; Goff, 2008).

Selenium and vitamin E: Likely due to impaired neutro-
phil function, selenium or vitamin E deficiency is associated
with increased incidence of retained placenta and mastitis.
Supplementing diets with 0.3 ppm selenium (the legal limit)
is recommended. This is particularly important when for-
ages are grown on selenium-deficient soils. Fresh pasture is
a good source of vitamin E. Cows in confinement may benefit
from increasing dietary vitamin E concentrations to between
2,000 and 4,000 IU per day for three weeks before to three
weeks after parturition.

Copper and zinc: Deficiencies of copper and zinc not only
decrease immune function but can reduce reproductive
performance. Adequate quantities of these and other micro
minerals should be fed during the dry period for placental
transfer to the fetus and accumulation in the liver and other
tissues to increase concentrations in colostrum and milk for
the new born.

Growing heifers: 200-1,300 lb.

Nutrient requirements of growing Holstein heifers at three
ages are in Table 8; target weights are: first breeding weight –
827 lb.; first calving weight – 1,232 lb.; mature weight –
1,504 lb. All heifers are projected to calve at 24 months of

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age. Also shown in Table 8 is the effect of cold stress and a wet hair coat on the daily gain of 650 lb. heifers (12 months of age).

The data in Table 8 illustrate two common problems observed in heifer growth. First, heifers raised in a cold and wet environment often will not gain weight. The additional nutrients required in this kind of environment for maintenance surpass the nutrients available from the diet. Thus, heifers do not gain and often lose weight during winter and spring months. Secondly, pregnant heifers have a low nutrient requirement compared to their DMI and, thus, it is easy to fatten pregnant heifers even on a relatively low-energy diet. Even feeding low amounts of corn silage, such as in Table 8, provides pregnant heifers with considerably more energy than required to meet target gains.

Young calves: birth to 200 lb.

The nutrient requirements of the calf are divided into three phases corresponding to the changes and development of the digestive tract:

1. Liquid feeding phase, when all nutrient requirements are met by milk or milk replacer. Generally the first three weeks of life.

2. The transition phase, when the consumption of both liquid and starter contribute to meeting the nutrient requirements of the calf. This phase is generally from three to six weeks of age.

3. The ruminant phase, when calves are consuming all solid feed and microbial fermentation in the rumen is contributing to meeting the nutrient requirements of the calf.

Energy and protein requirements of calves fed milk or milk replacer only, a combination of milk or milk replacer and starter and starter or starter feed only is shown in Table 9.

Effect of environment on calf energy requirement. The energy requirements provided in Table 9 are based on a calf being in a thermal neutral zone and not expending energy to dissipate heat or invoke energy conserving mechanisms to retain heat. The thermal neutral zone for calves varies depending on age and DMI. Calves less than three weeks of age have a thermal neutral zone of 59-77°F, whereas calves older than three weeks can tolerate temperatures down to about 15°F before heat-conserving mechanisms are invoked. The increase in ME required for maintenance with increasing cold temperatures is shown in Table 10.

For many calves housed outdoors during the winter, the extended days at the lower end of critical temperatures will result in no gain or even weight loss; increased maintenance energy requirement depletes all of the consumed energy leaving no energy for growth. Feeding additional amounts of milk or milk replacer will help offset the increase in maintenance ME at lower temperatures, but at very low temperatures, calves cannot consume enough energy to maintain their bodyweight.

References


The American public is increasingly bombarded with mixed messages and misinformation regarding the safety and quality of the nation’s food supply. As a result, consumer confidence is sometimes threatened, as is the very livelihood of animal agriculture and U.S.-based food production.

In order to ensure meat, milk and eggs a future spot on the dinner table, the editors of Feedstuffs developed Feedstuffs FoodLink, a multi-media communication tool designed to provide both producers and consumers with the information and facts they need to have informed discussions and make informed decisions.

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