Feeding Lactating Cows

The Basics

Energy/Carbohydrates

Energy Terms

- Total Digestible Nutrients (TDN)
  - Expressed as % or lb
- Net Energy for Lactation (NE\textsubscript{L})
  - Expressed as Mcal/lb or Mcal

Energy Partitioning

During Early Lactation
1. Maintenance
2. Milk Yield
3. Growth
   - Weight Gain
   - Reproduction

During Late Lactation
1. Maintenance
2. Reproduction
3. Milk Yield
   - Growth
4. Weight Gain

Energy Requirements

- Maintenance
  - 10 Mcal/d (13 lb ration DM)
  - ↑ 10 – 15% for pastured and cold stress
- Growth
  - ↑ 20% (1st lact) to 10% (2nd lact) above maintenance (1.3 lb ration DM)
- Milk Yield
  - 0.31 Mcal per lb of milk (0.4 lb ration DM)
Energy Requirements

- Reproduction
  - 3 Mcal/d last two months of pregnancy (4 lb ration DM)
- Weight Gain
  - 2.33 Mcal per lb gain (3 lb ration DM)

Energy Requirements

![Energy Requirements graph]

CHO Fractions

- Fiber Carbohydrates
  - Cellulose
  - Hemicellulose
  - Lignin
- Non-fiber Carbohydrates
  - Starch
  - Sugars
  - Pectin
  - Organic Acids

![Diagram of a plant cell showing cell wall structure]

Acid Detergent Fiber (ADF)

- Lignin and cellulose
- Cell wall of the plant
- Digestibility is low
- Predicts energy level
- Increases as plant matures

Relationship of NEL and ADF in Corn Silage

![Relationship of NEL and ADF graph]
Neutral Detergent Fiber (NDF)

- Total cell wall
- ADF + hemicellulose
- Modest digestibility
- Predicts feed intake
- Increases as plant matures

Effect of Ration NDF on Intake

- Optimal NDF 27 to 32% DM
- Depends on level of milk production
- As milk yield increases, optimal NDF decreases.
- As milk yield decreases, optimal NDF increases

Acidosis

- Low rumen pH (<6.0)
- Cause
  - Type of diet (low fiber or high concentrate)
  - Physical form of feeds (small particle size)
- Effect
  - Shift rumen microbe population & VFA pattern
  - Slow the rate of feed passage
  - Lower feed digestibility

Composition of Selected Feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>ADF (% of DM)</th>
<th>NDF (% of DM)</th>
<th>NEL (Mcal/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Silage</td>
<td>25</td>
<td>41</td>
<td>0.68</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>30</td>
<td>49</td>
<td>0.65</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>37</td>
<td>50</td>
<td>0.56</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>28</td>
<td>38</td>
<td>0.68</td>
</tr>
<tr>
<td>Barley</td>
<td>7</td>
<td>18</td>
<td>0.88</td>
</tr>
<tr>
<td>Corn</td>
<td>3</td>
<td>9</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Effective NDF (eNDF)

- Long particles stimulate rumination
- Rumination leads to saliva production
  - Buffers rumen
  - Small particle size forage similar to grain
  - Rapid fermentation in rumen
- Goal: 70 – 75% of NDF from forage

NDF and Effective NDF

<table>
<thead>
<tr>
<th>Feed</th>
<th>NDF (% of DM)</th>
<th>eNDF (% of NDF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Silage, 3/8”</td>
<td>41</td>
<td>81</td>
</tr>
<tr>
<td>Corn Silage, &lt;3/8”</td>
<td>41</td>
<td>71</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>38</td>
<td>92</td>
</tr>
<tr>
<td>Brewers</td>
<td>49</td>
<td>18</td>
</tr>
<tr>
<td>Distillers</td>
<td>46</td>
<td>4</td>
</tr>
<tr>
<td>Whole Cottonseed</td>
<td>52</td>
<td>100</td>
</tr>
<tr>
<td>Soy Hulls</td>
<td>66</td>
<td>34</td>
</tr>
<tr>
<td>Wheat Midds</td>
<td>35</td>
<td>2</td>
</tr>
</tbody>
</table>
Non-fiber Carbohydrates (NFC)

- Sugars
- Starch
- Pectin - citrus and beet pulp
- Organic acids - fermented feeds
- NFC = 100 - %NDF - %CP - %Fat - %Ash
- NFC and NDF vary inversely
- Optimal range - 35 to 45% DM

NFC of Feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>NDF</th>
<th>NFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa Hay</td>
<td>43</td>
<td>22</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>Corn</td>
<td>13</td>
<td>68</td>
</tr>
<tr>
<td>Barley</td>
<td>23</td>
<td>61</td>
</tr>
<tr>
<td>Soy hulls</td>
<td>67</td>
<td>14</td>
</tr>
</tbody>
</table>

Protein

- Maintenance
  - 1 lb/d
- Growth
  - ↑ 20% (1st lact) to 10% (2nd lact) above maintenance (0.2 lb/d)
- Milk Yield
  - 0.08 lb per lb of milk

Protein Requirements

- Reproduction
  - 2 lb/d last two months of pregnancy
- Weight Gain
  - 0.3 per lb gain

Protein Requirements

Cow producing 65 lb milk, pregnant, growing, gaining weight
Protein Fractions

1. Rumen Degradable Protein (RDP)
   - Degraded to ammonia by microbes
   - Microbial growth depends on amount of CHO fermented in the rumen
   - Microbial CP (g/day) = 0.130 x kg TDN
   - Soluble protein (urea < 0.4 lb/d)

2. Rumen Undegradable Protein (RUP)
   - Pass from rumen to small intestine

Protein Supplements

<table>
<thead>
<tr>
<th>Source</th>
<th>CP (% DM)</th>
<th>Soluble (% CP)</th>
<th>RDP (% CP)</th>
<th>RUP (% CP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewers</td>
<td>30</td>
<td>4</td>
<td>34</td>
<td>66</td>
</tr>
<tr>
<td>Canola</td>
<td>40</td>
<td>32</td>
<td>63</td>
<td>37</td>
</tr>
<tr>
<td>CS Meal</td>
<td>46</td>
<td>20</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>Distillers</td>
<td>30</td>
<td>6</td>
<td>26</td>
<td>74</td>
</tr>
<tr>
<td>Fish Meal</td>
<td>68</td>
<td>21</td>
<td>41</td>
<td>59</td>
</tr>
<tr>
<td>48% SBM</td>
<td>55</td>
<td>20</td>
<td>65</td>
<td>35</td>
</tr>
</tbody>
</table>

RUP Sources

<table>
<thead>
<tr>
<th>Source</th>
<th>CP (% DM)</th>
<th>RUP (% CP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Meal</td>
<td>93</td>
<td>75</td>
</tr>
<tr>
<td>CG Meal</td>
<td>67</td>
<td>59</td>
</tr>
<tr>
<td>Feather Meal</td>
<td>86</td>
<td>70</td>
</tr>
<tr>
<td>Fish Meal</td>
<td>67</td>
<td>65</td>
</tr>
<tr>
<td>Prolak</td>
<td>72</td>
<td>66</td>
</tr>
<tr>
<td>Soy Plus</td>
<td>47</td>
<td>55</td>
</tr>
</tbody>
</table>

Fats and Oils
Adding Fats to Rations

- Common diets contain 2 to 3% fat
- Why add fat?
  - Intake limiting factor - 2.25x greater than CHO
  - Replace highly fermentable CHO
  1 lb ground corn = 0.88 Mcal NE
  1 lb animal/vegetable fat = 2.65 Mcal NE
- Too much impairs fiber digestion → Reduced feed intake

Problems with Fat

- Unsaturated fats depress fiber digestion more severely than saturated fats
- Saturated fats less digestible than unsaturated fats

Milk Response to Added Fat

Total Unsaturated Fatty Acids (UFA) Values for Fat Sources

<table>
<thead>
<tr>
<th>Fat Source</th>
<th>% UFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Booster</td>
<td>15</td>
</tr>
<tr>
<td>Megalac</td>
<td>50</td>
</tr>
<tr>
<td>Beef Tallow</td>
<td>45</td>
</tr>
<tr>
<td>Animal-Vegetable</td>
<td>52</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>53</td>
</tr>
<tr>
<td>Restaurant Grease</td>
<td>71</td>
</tr>
<tr>
<td>Cottonseed Oil</td>
<td>72</td>
</tr>
<tr>
<td>Soybean Oil</td>
<td>85</td>
</tr>
<tr>
<td>Canola Oil</td>
<td>90</td>
</tr>
</tbody>
</table>

How Much Fat to Add?

- 2 to 3% DM naturally in diet
- 3% DM from unprotected sources
  - whole oil seeds
  - animal/vegetable fats
- 1 to 2% DM from protected sources
  - Megalac
  - Energy Booster

Minerals & Vitamins
Required Minerals

- Macrominerals
  - Fed as g per day expressed as % DM
    - Ca, P, Mg, K, Na, Cl, S
- Microminerals (Trace)
  - Fed as mg per day expressed as ppm (mg/kg DM)
    - Co, Cu, Fe, I, Mn, Se, Zn

Macrominerals

- Ca: P ratio
- P – Environment
- Electrolytes – Heat Stress
- K – Milk Fever
- Mg – Grass Tetany

Dietary Mineral Concentrations

<table>
<thead>
<tr>
<th>Milk</th>
<th>Ca</th>
<th>P</th>
<th>Na</th>
<th>Cl</th>
<th>K</th>
<th>Mg</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>lb/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>0.60</td>
<td>0.37</td>
<td>0.21</td>
<td>0.26</td>
<td>1.04</td>
<td>0.19</td>
<td>0.20</td>
</tr>
<tr>
<td>75</td>
<td>0.56</td>
<td>0.34</td>
<td>0.21</td>
<td>0.24</td>
<td>1.02</td>
<td>0.18</td>
<td>0.20</td>
</tr>
<tr>
<td>50</td>
<td>0.52</td>
<td>0.31</td>
<td>0.22</td>
<td>0.22</td>
<td>1.00</td>
<td>0.16</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Trace Minerals Requirements

<table>
<thead>
<tr>
<th>Micromineral</th>
<th>PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co</td>
<td>0.11</td>
</tr>
<tr>
<td>Cu</td>
<td>15</td>
</tr>
<tr>
<td>I</td>
<td>0.5</td>
</tr>
<tr>
<td>Fe</td>
<td>15</td>
</tr>
<tr>
<td>Mn</td>
<td>15</td>
</tr>
<tr>
<td>Se</td>
<td>0.3</td>
</tr>
<tr>
<td>Zn</td>
<td>60</td>
</tr>
</tbody>
</table>

Method of Feeding

- Force feeding - recommended method
  - Optimal method is in TMR
  - Use of grain carrier
- Free choice - cafeteria style
  - Supplying unmixed supplements of Dical, salt, limestone, etc

Vitamins

- Required
  - A
  - D
  - E
- B vitamins produced in rumen