Dairy Nutrition

- Considerations
  - Nutrient requirements
  - Nutrient content of feeds
    - Sampling for accuracy
  - Processing of feeds
  - Cost of feed
    - Availability
    - Contracting
  - Management style
  - Data evaluation

Understanding Dairy Nutrition

- Nutrients
- Dietary formulation
  - Sampling feed ingredients
- Feeding management
- Cow observation

![Graph showing milk production, dry matter intake, and body weight over months](image)
Nutrient Requirements (NRC)

Nutrient needs of animal
• Based on body weight, milk production, milk fat content, pregnancy and growth

Feed tables with “book” values
• Nutrient content of feeds

http://www.nap.edu/catalog.php?record_id=9825#toc

Milk Rules of Thumb
• Peak
  – 30 to 70 days postpartum
  • Second month on DHI test
    – Heifers (1st lactation) possibly later
    – Peak times 200 equals lactation total potential
  • Example: 100 # X 200 = 20,000#

• Persistency
  – 1st lactation cows drop 6% per month after peak
  – Older cows drop 9% per month after peak

Nutrition Based on Dry Matter

Dry matter = as fed x % dry matter

Dry matter % = dry matter x 100% as fed

Dry matter intake is always less than as fed intake!
Dry Matter Intake Guides

Dry Cows: \((B.W. \times 0.0185)\)
23 pounds of DM for maintenance (1250#)

Milk Cows:
\((0.0185 \times B.W.) + (0.305 \times \text{lb } 4\% \text{ FCM})\)

4% FCM = \((0.4 \times \text{lb Milk}) + (15 \times \text{lb Fat})\)

1 lb of DM \(\uparrow\) milk yield 2 - 2.5 lb

NRC Dry Matter Intake
lb DMI per day

<table>
<thead>
<tr>
<th>4% FCM Milk Yield (lb)</th>
<th>880 lb BW</th>
<th>1,100 lb BW</th>
<th>1,320 lb BW</th>
<th>1,540 lb BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>32</td>
<td>35</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>66</td>
<td>39</td>
<td>43</td>
<td>46</td>
<td>49</td>
</tr>
<tr>
<td>88</td>
<td>48</td>
<td>51</td>
<td>53</td>
<td>55</td>
</tr>
<tr>
<td>110</td>
<td>NA</td>
<td>59</td>
<td>62</td>
<td>63</td>
</tr>
<tr>
<td>132</td>
<td>NA</td>
<td>NA</td>
<td>71</td>
<td>74</td>
</tr>
</tbody>
</table>

Changes in Nutrient Requirements

<table>
<thead>
<tr>
<th>Body Wt + Milk (3.5%)</th>
<th>NEL (Mcal)</th>
<th>CP (lb)</th>
<th>Ca (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400 lb BW</td>
<td>10.12</td>
<td>0.932</td>
<td>0.057</td>
</tr>
<tr>
<td>1400 lb BW + 60 lb/d</td>
<td>10.12 +</td>
<td>0.932 +</td>
<td>0.057 +</td>
</tr>
<tr>
<td></td>
<td>18.6 =</td>
<td>5.04 =</td>
<td>0.18 =</td>
</tr>
<tr>
<td></td>
<td>28.72</td>
<td>5.972</td>
<td>0.237</td>
</tr>
<tr>
<td>1400 lb BW + 150 lb/d</td>
<td>0.12 +</td>
<td>.932 +</td>
<td>0.057 +</td>
</tr>
<tr>
<td></td>
<td>46.5</td>
<td>12.6</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>56.62</td>
<td>13.532</td>
<td>0.507</td>
</tr>
</tbody>
</table>
### Dilution of Maintenance Costs

(\% of nutrient for milk)

<table>
<thead>
<tr>
<th>Body Wt + Milk (3.5%)</th>
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<tr>
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<td>5.972</td>
<td>0.237</td>
</tr>
<tr>
<td></td>
<td>64.8%</td>
<td>84.4%</td>
<td>75.9%</td>
</tr>
<tr>
<td>1400 lb BW + 150 lb/d</td>
<td>56.62</td>
<td>13.532</td>
<td>0.507</td>
</tr>
<tr>
<td></td>
<td>82.1%</td>
<td>93.1%</td>
<td>88.8%</td>
</tr>
</tbody>
</table>

### Energy Sources

- **Carbohydrates (Fermentable)**
  - Fiber (Cell wall)
    - Cellulose, hemicellulose
  - Non-Fiber (Cell contents)
    - Starch, sugars
- **Fats and Oils (Not fermentable)**

![Diagram of a plant cell showing cell wall structure](image)
ADF  
(Acid Detergent Fiber)
* Lignin and cellulose
* Cell wall of the plant
* Digestibility is lower
* Increases as plant matures
* Predicts energy level

NDF  
(Neutral Detergent Fiber)
* Total cell wall
* ADF + hemicellulose
* Modest digestibility
* Dry matter intake control
* Increases as plant matures

Total Digestible Nutrients  
(TDN)
Expressed as % or lb
• Older system; moving to each “nutrient” needs

• Digestible Protein (70%)
• Digestible Crude Fiber (30 - 40%)
• Digestible Nitrogen Free Extract (80%)
• Digestible Ether Extract (60 - 80%) \( \times 2.25 \)
Net Energy Basis
Expressed as Mcal/lb

- Net Energy Maintenance $NE_M$
- Net Energy Lactation $NE_L$
- Net Energy Growth $NE_G$

Partitioning of ration (60% Alfalfa & 40% Corn) energy and losses in a lactating cow

- Gross Energy in feed (100%)
- Digestible Energy (70%)
- Loss in feces (30%)
- Metabolizable Energy (60%)
- Losses in urine (5%) and in gas (5%)
- Net Energy (40%)

Net energy system

Forage Analysis

Proteins, Ether Extract (Lipids), Ash (Minerals)

Nitrogen-Free Extract

Cell Contents

Sugar, Starches, Pectins

Hemicellulose

Alkali-Soluble

Alkali-Insoluble

Cellulose

Crude Fiber

Forage analysis showing Crude Fiber (Green) versus Van Soest (Yellow)
Protein

- \( CP = \text{Nitrogen (N)} \times 6.25 \)
- \( 100 \text{ lb CP} = 16 \text{ lb N} \)
- \( 100 / 16 = 6.25 \)
- Example: Alfalfa hay =
  - \( 3\% \text{ N} \times 6.25 = 18.75\% \text{ CP} \)

Total Crude Protein

- \( CP = \text{Nitrogen (N)} \times 6.25 \)
- \( 100 \text{ lb CP} = 16 \text{ lb N} \)
- \( 100 / 16 = 6.25 \)
- Example: Alfalfa hay =
  - \( 3\% \text{ N} \times 6.25 = 18.75\% \text{ CP} \)

Available Protein

- Protein available for digestion
- Should be 90% or more of CP
- Less than 90% CP available indicates:
  - Heat damage
  - Excessive maturity at harvest
Unavailable Protein

- Protein unavailable for digestion
- Should be less than 10% of CP
- If greater than 10% of CP indicates:
  - Heat damage
    - Maillard Reaction
    - Carmelized protein
      - Pay attention to distillers grains and other heated protein sources
  - Bound protein
  - ADF-N (ADIN)

Avoid Heating & Carmelization in Silages

- Proper stage of maturity
- Correct moisture content
  - Oxygen-limiting (45 - 50%)
  - Conventional (55 - 60%)
  - Bunkers & bags (65 - 70%)
- Length of chop
- A tight silo or pack well
- Fill rapidly
- Seal if needed

Crude Protein (CP) = Nitrogen x 6.25
Contains Protein & NPN

Available CP

Rumen Degradable CP
May be soluble or insoluble
- Used by microbes

Rumen Undegradable CP
Largely insoluble and passes to small intestine

Unavailable CP
- Bound or ADF-CP (ADIN)
- ↑ when protein is overheated
- Mostly undigestible & excreted in feces

Digestible CP in intestines & supplies amino acids to cow
Undigestible CP in intestines & excreted in feces
Nonprotein Nitrogen (NPN)

• N not in a protein
• True protein is N in a long chain of amino acids
• NPN must be incorporated into microbial protein to be beneficial
• Examples of NPN
  – Urea
  – Monoammonium phosphate
  – Free amino acids

Sources

• Some slides adapted from Dairy Nutrition & Management (ANSCI 200/492), University of Illinois at Urbana-Champaign, Dr. Mike Hutjens