Nutritive Value of Feeds
Chapter 12
A working knowledge of the nutrient composition of available feeds is an integral part of a successful beef cattle operation.
The rumen **fermentation** process allows cattle to obtain feeds from a wide range of resources.

Rumen fermentation and rumen function is discussed extensively in chapter 10 of the Beef Cattle Manual.
Nutrient Categories

- Water
- Carbohydrates
- Protein
- Lipids (fats & oils)
- Minerals
- Vitamins
Chemical Composition of Yearling Steers

Carstens et al., 1991
Nutritive value is determined by nutrient concentration and nutrient digestibility

- Digestion trials are used to determine digestibility of chemical components
- Must know
  - Chemical composition
  - Digestibility of each chemical component
Determining Nutritive Value

- Scientists and commercial laboratories have developed methods to determine both chemical composition and digestibility from a sample
- Methods to estimate nutritive value
  - Rely on “book” or tabular values (12.1)
  - Have an individual sample analyzed by a commercial laboratory
Proximate Analysis

Feed

- Water
- Ash
- Carbohydrate
- Protein
- Fat

Fiber

Non-fiber
Feed Composition Tables

- Provide basic guidelines of nutrient composition for ration formulation
- Limited by use of “average” values
- Feedstuffs generally vary widely in nutrient composition
- Producers should test their own forages, and other feed commodities prior to feeding if not previously tested
Variation in Protein Concentration of Coastal Bermudagrass Hay

A nutrient analysis takes the guess work out!
Dry Matter

* That portion of the feed that is not water

* Incorporates all the essential nutrients except water

* No specific “requirement” for dry matter

* Dry matter intake controlled by many factors
Fiber

Detergent fiber system:

- NDS
- NDF

- Starches, sugars etc., Near 100% digestible
- Fiber, extremely variable in digestibility
NDF - DMI Relationship
Detergent Fiber System, cont.

- Carbohydrate
  - NDS
  - NDF
    - Hemicellulose (highly dig.)
    - ADF
      - Lignin (nearly indig.)
      - Cellulose (variable)
More on Fiber

- Digestibility of forage fiber is proportional to the amount of lignin in the plant material
- Effective neutral detergent fiber (eNDF) stimulates rumen motility, and health
Fiber Digestibility Effects

- Effective neutral detergent fiber (eNDF) stimulates chewing, salivation, rumen motility, and therefore gut health.
- Highly related to rumen pH
Effective NDF and Rumen pH

\[ \text{pH} \]

\[ \text{eNDF, \% of DM} \]

\[ R^2 = 0.52 \]

Pitt et al., 1996
Application of eNDF

- If pH less than 6.2, fiber digestion declines
  Pitt et al., 1996
- Forage digestibility near 0 with low pH (cellulolytic bacteria)
- Corresponds to 20% eNDF in diet dry matter

*
### eNDF in Common Feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>eNDF % DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat Middlings</td>
<td>1</td>
</tr>
<tr>
<td>Corn, Steam flaked</td>
<td>4</td>
</tr>
<tr>
<td>Soybean Hulls</td>
<td>6</td>
</tr>
<tr>
<td>Corn, Cracked</td>
<td>7</td>
</tr>
<tr>
<td>Alfalfa Dehydrated 17% CP</td>
<td>8</td>
</tr>
<tr>
<td>Corn Gluten Feed</td>
<td>14</td>
</tr>
<tr>
<td>Barley Malt Sprout Pellets</td>
<td>16</td>
</tr>
<tr>
<td>Alfalfa Cubes</td>
<td>18</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>31</td>
</tr>
<tr>
<td>Wheat Silage</td>
<td>37</td>
</tr>
<tr>
<td>Whole Cottonseed</td>
<td>40</td>
</tr>
<tr>
<td>Peanut Hulls, coursely ground</td>
<td>73</td>
</tr>
<tr>
<td>Cottonseed Hulls</td>
<td>88</td>
</tr>
</tbody>
</table>

Sniffen, Preston and NRC, 1996
Protein

- Crude protein (CP) is the amount of nitrogen times 6.25.
- Degradable intake protein (DIP) is expressed as a percentage of CP.
- Undegradable intake protein (UIP) or bypass protein is calculated by subtracting the DIP value from 1.0
Energy

- Table values expressed both as total digestible nutrients, and net energy systems.
- TDN is the most common value used in cow/calf and stocker applications because it is easy to use and understand.
- The NE system is more accurate in estimating energy value of roughages and is more accurate when predicting animal performance.
Ether Extract

- Fats or lipids
- Contributes to energy value of feed
- To calculate energy value of EE component: Digestible EE x 2.25
- Oilseed Crops – Soybeans, Cottonseed, Canola
Chemical Analysis

- Basic
  - Dry matter
  - Ash (total mineral content)
  - Crude protein (N x 6.25)
  - Acid detergent fiber
  - TDN = 88.9 – (.779 x %ADF)

  Application is limited: originally intended for use with alfalfa hay

- Most labs offer complete proximate analysis
Estimating TDN from Chemical Components
Advantages of ADF Equations

- Simple, inexpensive
- Require only DM and ADF analysis
- ADF can be accurately determined with NIRS (quick and inexpensive)
- Less accurate than more complicated, expensive approaches
ADF Predicted DDM vs IVTD of Sorghum and Sudangrass

\[ y = 1.22x - 4.38 \]

\[ R^2 = 0.66 \]

Bean et al. 2000 & 2001

\( n = 344 \)
Calculating TDN using Proximate Analysis (Summative Approach)

- Feeds are fractioned into
  - Crude protein
  - Nonfiber carbohydrate (starch, sugars, pectins etc.)
  - NDF
  - Fat
  - Ash
  - Water

- True digestibility is calculated for each fraction
Protein, fat and NFC are assumed to be uniform in digestibility.

NDF is variable in digestibility.

Lignin and NDF covered by lignin is indigestible.
Analyses Required

Traditional systems
- Water
- Crude protein
- Crude Fiber or ADF

Cost = $10 - 20

Summative system
- Water
- Crude protein
- ADF
- Fat
- ADIN
- NDIN
- Ash
- NDF
- Lignin

Cost = $30 - 60
Minerals

- Macro minerals needed in large quantities and expressed in percent of dry matter (Na, Cl, Ca, P, K, S, Mg).
- Micro minerals needed in smaller quantities and expressed in terms of parts per million (Cu, Mn, Zn, Se, Co, I, Fe).
Summary

- Six essential nutrients
- Feed tables provide guidelines regarding the average chemical composition and nutritive value
- Nutrient analysis of forages and feed commodities
- Consider the differences in forage TDN calculations (ADF equation versus summative approach)
Questions?