Chapter 11: Range Animal Nutrition

1. Nutritional Components of Forages
   a. Protein
   b. Energy
   c. Phosphorus
   d. Vitamin A

2. Comparative Nutrition of Forages
   a. Grasses
   b. Forbs
   c. Shrubs

3. Comparative Nutrition of Range Animals
   a. Ruminants
   b. Monogastric
   c. Monogastric with enlarged cecum

4. Supplementing Range Livestock

5. Fecal Indicators of Dietary Quality

6. Range Nutrition Guidelines
Critical Nutrients to Range Livestock

1. Protein-most critical (cannot be stored)
2. Phosphorus-stored in bones
3. Energy-stored in fat
4. Vitamin A- stored in liver
Animal nutrition studies
Animal nutrition studies
Protein

Protein – complex combinations of amino acids (containing C, N, H, O, S) which are essential constituents of all living cells and of the diet of the animal.

Function of protein
1. Enzymatic catalysis
2. Transport and storage
3. Mechanical support
4. Immune protection
5. Coordinated motion
6. Nerve impulse transmission
7. Control of growth (hormones)
<table>
<thead>
<tr>
<th></th>
<th>CRUDE PROTEIN (%)</th>
<th>LIGNIN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grass</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stems</td>
<td>3.9</td>
<td>11.7</td>
</tr>
<tr>
<td>Leaves</td>
<td>12.3</td>
<td>8.9</td>
</tr>
<tr>
<td>Entire plant</td>
<td>6.2</td>
<td>11.0</td>
</tr>
<tr>
<td><strong>Forbs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stems</td>
<td>4.5</td>
<td>12.4</td>
</tr>
<tr>
<td>Leaves</td>
<td>14.1</td>
<td>8.5</td>
</tr>
<tr>
<td>Entire plant</td>
<td>9.5</td>
<td>10.2</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stems</td>
<td>6.3</td>
<td>20.6</td>
</tr>
<tr>
<td>Leaves</td>
<td>13.0</td>
<td>12.3</td>
</tr>
<tr>
<td>Current growth</td>
<td>11.6</td>
<td>15.0</td>
</tr>
</tbody>
</table>

*Source: Cook and Harris (1950).*
Some terminology

**Crude protein** - nitrogen content of the feed multiplied by 6.25. Feed protein contains about 16% nitrogen.

**Cell contents** - readily available carbohydrate protein of plant that supplies most of the energy particularly for small ruminants; this portion is virtually 100% digestible

- forb and shrub leaves have much higher cell content concentrations than grass leaves and stems.

**Cell wall** - fibrous portion of the plant which has low digestibility. Grass leaves and stems have higher total fiber than forb and shrub leaves.

**Lignin** - indigestible portion of the cell wall, it may reduce digestibility of other nutrients.
Figure 11.1 The nutritional composition of a plant cell. (From Van Soest 1982.)
More terminology

**Cellulose** - digestible part of the cell wall that can only be broken down by protozoa and bacteria. Grass leaves and stems have higher concentrations of cellulose than forb and shrub leaves.

However, the cellulose of grasses is less lignified than that of forbs and shrubs and therefore more digestible.

Large ruminants are best adapted for high cellulose (grass) diets.

**Crude fat** - lipids, volatile oils, resins, chlorophyll, alkali resins. Lipids have about 2.25 times the energy of carbohydrates. Crude fat is the same as ether extract.

**Ash** - inorganic or mineral components of a feed.
# Minerals

<table>
<thead>
<tr>
<th>Macro minerals</th>
<th>Micro minerals</th>
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<tbody>
<tr>
<td>Calcium</td>
<td>Iron</td>
</tr>
<tr>
<td>*Phosphorus</td>
<td>Iodine</td>
</tr>
<tr>
<td>Potassium</td>
<td>Copper</td>
</tr>
<tr>
<td>Sodium</td>
<td>Cobalt</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Fluorine</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Zinc</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Molybdenum</td>
</tr>
<tr>
<td>*Selenium</td>
<td>Manganese</td>
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</table>
## Function of Calcium and Phosphorus

<table>
<thead>
<tr>
<th>Calcium</th>
<th>Phosphorous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bone</td>
<td>1. Bones</td>
</tr>
<tr>
<td>2. Blood clotting</td>
<td>2. Enzyme component</td>
</tr>
<tr>
<td>3. Muscle function</td>
<td>3. Nucleic acid component</td>
</tr>
<tr>
<td>4. Enzyme activation</td>
<td>4. Lipid component</td>
</tr>
<tr>
<td>5. Hormone secretion</td>
<td>5. Protein component</td>
</tr>
<tr>
<td></td>
<td>6. Phosphate bonds are the energy currency of all life.</td>
</tr>
</tbody>
</table>
1. Calcium to phosphorus ratio is critical; this ratio should be from 2 Ca: 1 P to 1 Ca: 1 P

2. Vitamins - organic substances required by animals in very small amounts for regulating body processes –

3. Vitamin A - is the only one that may be deficient in range livestock diets

4. Vitamin A – synthesized from the carotene in plant tissue. Actively growing and green plant tissue provides adequate carotene for ruminants.
Functions of Vitamin A

1. Vision
2. Reproduction
3. Bone growth
4. Epithelial cells

- Water - animals will die more quickly if deprived of this nutrient than any other.
- Digestion - preparation of food for absorption by the gastrointestinal tract.
Antiquality Compounds

• Plant tannins - polymerized compounds distinguished from lignin by their relative solubility and ability to combine and form leather–like precipitates with proteins.

• Soluble phenolics- secondary plant compounds that can form irreversible complexes with proteins and thereby reduce protein digestibility once released from plant vacuoles during mastication (includes flavenoids, isoflavenoids and tannins).
Critical Nutrients to Range Livestock

1. Protein
2. Phosphorus
3. Energy
4. Vitamin A
Indicators of Forage Nutritional Quality

1. Nitrogen
2. Phosphorus
3. Neutral detergent fiber (total cell wall)
4. Lignin
Comparative Nutrition of Ruminants and Monogastrics

**Ruminants** - have enlarged compartment (rumen) that permits microbial degradation of food before it passes to the stomach (abomasum) (e.g. cow, deer, sheep, goat, elk, moose, etc.)
Characteristics of Ruminants

1. Can utilize fiber (cellulose) because rumen microbes have enzyme cellulase.
2. Microbes can synthesize protein from a nitrogen source.
3. Microbes can synthesize water soluble vitamins (B,C).
4. Inefficiently utilize high quality proteins.
5. Inefficient use of forages and feeds high in cell solubles and readily available carbohydrates.
6. Intake of forage is dependent on fiber concentration of forage – the higher the fiber concentration, the lower the intake.
Monogastric

*Monogastric* with cecum - cecum is enlarged portion of the large intestine that permits microbial degradation of fiber after it passes through the stomach. [rabbit, horse, granivorous birds, many rodents].

1. Less efficient use of fiber than ruminant.
2. More efficient use of cell solubles than ruminant.
3. Intake not restricted by fiber concentration in diet.
4. More efficient use of high quality proteins than ruminants.

5. Animals such as horse and rabbit that exhibit coprophagy (eat feces) can obtain both protein and phosphorus fecal residues. **Monogastric** animals without enlarged cecum such as man, dog and pig require diets low in fiber with high quality protein. Very little fiber digestion occurs in these animals and all essential amino acids and vitamins must be present in the diet.
Figure 11.5 Stylized representation of the digestive anatomy and arrangement of (a) ruminant, (b) monogastric with enlarged cecum fermenter, and (c) monogastric herbivores. 1, esophagus; 2, reticulum; 3, rumen fermentation compartment; 4, omasum; 5, stomach (abomasum); 6, small intestine; 7, cecum fermentation compartment; 8, large intestine; 9, anus. (Adapted from Huston and Pinchak 1991.)
Factors Governing Forage Selection by Large Ungulates

1. Body Size
2. Digestive System
3. Mouth size and shape
4. Rumen reticular volume
Mouth size and shape

Figure 11.4 Mule deer, unlike cattle, can utilize juniper as an emergency food in winter because their smaller mouths and lower total forage demand permit them to select those plant parts with the lowest levels of volatile oils.
Mouth size and shape
Fecal Indicators of Diet Quality

1. Fecal nitrogen
2. Fecal phosphorus
Supplementing Range Livestock

1. Protein supplementation
2. Energy supplementation
3. Mineral supplementation
Range Nutrition Guidelines

1. If one type of forage is deficient, then another one should be provided if possible.
2. Range livestock should be fed to prevent large weight losses during inclement weather.
3. Phosphorus supplementation is required on most ranges when forage is dormant.
4. If crude protein in forage drops below 7%, nitrogen should be supplemented.
5. If extended period occurs (4 to 6 months) when green forage is unavailable, vitamin A should be supplemented.
6. Diverse vegetation is best during periods when forage is dormant. Browse provides protein and grass provides energy.
Range Nutrition Guidelines cont.

7. If possible different classes of animals should be separated in the winter for different supplementation programs – middle aged animals have lower requirements than young growing animals.

8. Some weight loss by animals in winter (up to 10% of body weight) is desirable because of compensatory gain in the spring and summer.

**Compensatory gain** – extra gain of thin animal compared to fat animal.

**Stalling** – animal performs poorly when placed on high quality forage because of substandard nutrition level that results in excessive weight loss (more than 10% of body weight)
Figure 11.3 Crude protein content of fourwing saltbush at three utilization levels in northwestern Arizona. (From Meen 2000.)
Figure 11.4 Mule deer, unlike cattle, can utilize juniper as an emergency food in winter because their smaller mouths and lower total forage demand permit them to select those plant parts with the lowest levels of volatile oils.