Digestive System
Nutrient Requirements

• Change with:
  – Weight
  – Stage of Production
  – Level of Production
  – Age

• Change with:
  – Climate
  – Level of Wool Production
  – Physical Activity
  – Diseases and Parasite Load
  – Body Condition
Nutrients

- Water
- Energy:
  - Carbohydrates
- Protein
- Vitamins
- Minerals
Water

• Water is extremely important to the animal’s health and performance
  – Coolant
  – Transporter
  – Acts in chemical reactions

• For every 4 lbs of DM consumed, 1-1.5 gallons of water should be consumed
  – Typical ewe water consumption: 0.72 in winter, 2.2 summer
Energy

- **Digestible Energy (DE; Mcal)**
  - Basis for energy requirements
  - Maintenance, Lactation, and Growth

- **Metabolizable Energy (ME; Mcal)**
  - $ME = 82\% \text{ of } DE$

- **Total Digestible Nutrients (TDN; \% or lbs.)**
  - 1 lb. TDN = 2 Mcal of DE
Energy

• Most important nutrient
  – Inadequate energy limits performance more than any other nutritional deficiency

• Supplied through:
  – Carbohydrates (grains), fat, and excess protein (inefficient)
Energy

- Concentrates and roughages serve as the major source
- Commonly the most limiting nutrient
- High concentrate diets:
  - >ADG and FE than high forage diets at similar ME levels
- High intake animals have heavier digestive tracts and internal organs at the same age as low intake animals

(McLeod and Baldwin, 2000)
Protein

- Dietary protein $\rightarrow$ ruminal microorganisms $\rightarrow$ microbial protein $\rightarrow$ amino acids
- This is important because:
  
  **Quantity is most often more important than quality!!!**
  
  - Microbial protein is commonly adequate, however with low quality forage, additional protein might be required

- Overfeeding protein is expensive!
**Protein**

- Sheep and goats have higher protein requirements per body weight than other ruminants.
- Under very high production, bypass protein may increase productivity.
- More expensive than energy feeds.
- Can use non-protein nitrogen (NPN).
Bypass Proteins

• Low Bypass:
  – Soybean meal, casein, sunflower meal, peanut meal

• Medium Bypass
  – Cottonseed meal, dehydrated alfalfa meal, dried brewers grains

• High Bypass
  – Corn gluten meal, feather meal, fish meal
Nitrogen

• Nitrogen (% or lbs)
  – Important when considering feeding urea

• Crude Protein (CP, % or lbs)
  – Nitrogen x 6.25
  – Common terminology referring to nitrogen content of the diet
Nitrate Poisoning

- Drought stricken, frost damaged, or heavily fertilized fields may contain forages with high nitrate levels
  - Need to be tested!
  - 1-3% potassium nitrate indicates that feeds should be blended
  - Can be deadly!
MAJOR POINTS
GUIDANCE

Protocol:
Use the following chart to assess the body condition score (BCS) of breeding sheep.
This assessment should be done at least once a year, ideally after sheep have been shorn.
Record the BCS of each breeding sheep in the table below.

<table>
<thead>
<tr>
<th>BCS1</th>
<th>BCS2</th>
<th>BCS3</th>
<th>BCS4</th>
<th>BCS5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emaciated</td>
<td>Thin</td>
<td>Ideal</td>
<td>Fat</td>
<td>Obese</td>
</tr>
</tbody>
</table>

- **Emaciated**: Spine prominent and smooth. Muscles are very thin with no fat cover. (Chest and abdomen are skinny and bony)
- **Thin**: Spine prominent, muscles are present with a small amount of fat cover. (Fat is clearly visible)
- **Ideal**: Spine prominent, muscles are full with a small fat cover. (Muscle mass is evident)
- **Fat**: Spine prominent, muscles are full with a thick fat cover. (Muscle mass is suppressed)
- **Obese**: Spine and transverse processes are covered with fat. (Muscles are not visible)

Pressure is needed to feel the spine and transverse processes. The spine cannot be felt but a dimple can be seen over the spine. The muscles are very full and fat covers them. Bones are not visible and are covered with excessive fat.

Sheep with a BCS of less than 2 must receive additional management to increase their body condition score.

Any animal not responding to management, where their body condition has deteriorated further, must be euthanized.

<table>
<thead>
<tr>
<th>Animal ID</th>
<th>BCS</th>
<th>Treatment / Action taken</th>
<th>Outcome</th>
</tr>
</thead>
</table>

Adapted from “Body Condition Scoring of Sheep” by J.M. Thompson and A. Meyer (Oregon State University)
BREEDING: EWE AND RAMS
• Also maintain condition
  – Breeding is the most stressful time
  – BCS higher prior to breeding
• Early growth:
  – Heavy concentrate feeding vs. Slow growth
    • Bent legs, wool, etc.
• Maintenance
Overall Ewe/Doe Management

The quantity & quality of what sheep/goats eat (nutrition or energy intake) controls their fatness (body condition), Which in turn directly affects a number of production factors including:

Lamb/kid survival
Fiber production of both females & their progeny
Ewe/Doe Diets, Production Stage

- Maintenance
- Flushing
- 1st 15 wks gestation
- Last 5 wks gestation
- Early Lactation
- Late Lactation

Graph showing dry matter, TDN, and CP levels across different stages of production.
Ewe/Doe Management

• Establishing target BCS at breeding and lambing/kidding increases flock performance and future management
  – Feeding
  – Prevent common health issues
    • Toxemia
    • Calcemia
    • Dystocia
Pregnancy Toxemia

• Ketosis/Pregnancy disease/Lambing sickness/twin-lamb/kid disease
• Principal: low blood sugar (glucose), (-) energy
• Onset: triggered by stress
  – Nutritional
  – Inclement weather
• Most prevalent:
  – When carrying 2+ lambs or kids
  – Ewes/does that are extremely fat or excessively thin
  – 1-3 wks prepartum
Preg Tox

• Prevention
  – BCS of 3 at breeding; Aim for BCS 3-3.5 at parturition
    • Plan for 3-4# good quality hay (>10% CP) and 1.5# grain/hd daily in late gestation
  – Fetal Counts (feed)
  – Do not allow free-choice feeding in first 4 mos of pregnancy
  – Supplement concentrates in last 2-4 wks of gestation or access to lush pasture
  – If severe weather, may increase to 2-3# grain/hd/d divided into 2 feedings
  – Parasite management
Preg Tox Treatment

• Glucose drench
  – 60-100 mL/d for 3 days
  – Can add CA, insulin, and potassium
  – Can also had electrolyte solutions

• Offer good quality hay & oats

• Sometimes induction necessary
  – Dexamethasone (20 mg, IV or IM)
  – Occurs within 24 to 72 hrs (36 hrs)
Hypocalcemia or Milk Fever

- **Cause:** decreased calcium intake when requirements increase
- **Timing:** Late gestation, early lactation
  - 6 wks prior to 10 wks post-parturition
  - Commonly: 1-3 wks prepartum
- **Target:** Ewes/does carrying multiples
- **Can be concurrent with preg tox**
- **Nutrition and mobilization**
- **<5% of flock, up to 30%**
HC or Milk Fever

• Treatment:
  – Ca Borogluconate IV (50-150 mL of 23% solution)
  – Oral or SQ administration to prevent relapse
  – Can cause arrhythmias
  – Can mix
    • Above with:
      • With 1 L of a 5% dextrose solution
      • Administer over 10 min period
## Feed Additives

<table>
<thead>
<tr>
<th>Animal</th>
<th>Additive</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamb</td>
<td>Chlorotetracycline</td>
<td>Gain, feed efficiency, enterotoxemia</td>
</tr>
<tr>
<td>Breeding ewes</td>
<td>Chlorotetracycline</td>
<td>Vibrionic abortion</td>
</tr>
<tr>
<td>Sheep</td>
<td>Oxytetracycline</td>
<td>Gain, feed efficiency, scours prevention and treatment, enterotoxemia</td>
</tr>
<tr>
<td>Sheep</td>
<td>Lasalocid</td>
<td>Coccidiosis</td>
</tr>
<tr>
<td>Lambs</td>
<td>Decoquinate</td>
<td>Coccidiosis</td>
</tr>
<tr>
<td>Lambs</td>
<td>Ammonium Chl.</td>
<td>Urinary calculi</td>
</tr>
<tr>
<td>Sheep</td>
<td>Thiabendazole</td>
<td>Roundworms</td>
</tr>
</tbody>
</table>
Minerals

• Sixteen essential minerals:
  – Required for skeletal and nervous systems, health, growth, and reproduction

• Minerals of importance:
  – Salt, calcium, phosphorus, magnesium, potassium, sulfur, copper
Salt Requirement

- **Requirement:** 0.5 - 1.0% of diet
  - Provided in ration or as loose mineral (covered)
  - Purchased with or without other trace minerals

- **Deficiency:** Feed consumption, water intake, milk production, growth rate, chewing wood/dirt.

- **Toxicity:** Death possible, but not likely.
Calcium Requirement

• Requirement: 0.2 – 0.82% of diet
  – Most forages are adequate
  – Ground limestone, dicalcium phosphate

• Deficiency: Abnormal bone development (rickets), tetany (muscle spasms), urinary calculi. Late gestation and early lactation.

• Toxicity: Not likely, but may cause deficiency in other minerals.
Phosphorus Requirement

• Requirement: 0.16 – 0.38% of diet
  – 2:1 to 7:1 calcium to phosphorus ratio
  – Most grains are excessive
  – Dicalcium phosphate

• Deficiency: Rickets, slow growth, decreased appetite

• Toxicity: Urinary calculi in rams and wethers!
  – Treat with 7-10 grams/head/day of ammonium chloride
Magnesium Requirement

- **Requirement:** 0.12 - 0.18% of diet
  - Plant protein sources
  - Magnesium carbonate, oxide, and sulfate

- **Deficiency:** Skeleton, tetany (frothing at mouth, falling on side, salivation, decreased appetite, death)
  - Lactating ewes grazing spring grass (high potassium)

- **Toxicity:** Not likely
Potassium Requirement

- **Requirement:** 0.50 – 0.80% of diet
  - Most forages are adequate, grains may be low
  - Potassium chloride or sulfate

- **Deficiency:** Listlessness, stiffness, convulsions, death

- **Toxicity:** 3% of diet dry matter causes depression of Mg absorption (tetany)
Sulfur Requirement

- Requirement: 0.14 – 0.26% of diet
  - Most feedstuffs are adequate
  - Distillers grains are extremely high!
  - Sodium methionine and sulfate

- Deficiency: Loss of appetite, reduced gains, reduced wool growth, wool shedding

- Toxicity: 0.4% of diet
  - Decreased intake
  - Ties up Copper and Molybdenum
Copper Requirement

• **Requirement:** 7 – 11 ppm
  – Most feedstuffs are adequate, but Sulfur and Molybdenum tie up copper
  – Copper sulfate (0.5% of ration)

• **Deficiency:** decreased immune status, swayback, stringy wool, infertility

• **Toxicity:** 25 ppm
  – Red blood cell breakage, death!
  – Don’t use mineral supplements for other animals!
  – Drenching with 100 milligrams of ammonium molybdate and 1 gram of sodium sulfate.
Vitamins

• All sheep require vitamins A, D, and E.

• Lambs may also require B complex.
  – After rumen develops, microorganisms synthesize these vitamins.

• Vitamin C is synthesized by body tissues.
Vitamin A Requirement

- Requirement: 21 IU/lb live weight
  - Green forages contain B-carotene which is converted to Vit. A
  - Grains are poor sources
  - Vitamin A, D, and E injection prior to lambing

- Deficiency: Growth retardation, retained placenta, reproductive failure, night blindness, dead lambs.

- Toxicity: Not likely
Vitamin D Requirement

- Requirement: 252 IU/100 lb live weight
  - Sun-cured hay
  - Grains are poor sources
  - Vitamin A, D, and E injection prior to lambing

- Deficiency: Rickets

- Toxicity: Not likely
Vitamin E Requirement

• **Requirement:** 9 – 10 IU/lb of diet
  – Vitamin E or selenium injection
  – Alfalfa is a good source
  – Vitamin A, D, and E injection, especially for lambs

• **Deficiency:** White muscle disease
  – Stiff rear legs, arched back, tuck-up rear legs
  – Same affect as selenium deficiency (not a huge problem in ND)
  – Corn diets can contribute to deficiency (high Vit. E)

• **Toxicity:** Not likely
Vitamin B Complex Requirement

Thiamine, B₂, niacin, B₆, pantothenic acid, folic acid, B₁₂, biotin, and choline

• Requirement: Not required in diet, synthesized in rumen.

• Exception: Polioencephalomalacia in early-weaned and feedlot lambs on high-concentrate diets
  – Treat with Thiamin injection
  – Symptoms: Down on side, paddling with feet, head thrown back
Urolithiasis

- Obstruction in urethral tract; males
  - Dietary imbalance, water restriction, urine pH
    - Ca Carbonate stones: diets low in Phosphorus and Mg
    - Silica: high silicone content, combined with Cu and Zn deficiencies
    - Struvite: grain-based diets, high in phosphorus, low in Ca
  - Urine pH < 7.0 (silicate), >7.0 (apatite, calcium, struvite)
- Symptoms:
  - Depression, stretching, tail swishing, pain during urination, dribbling urine, appearance of bloat (water belly)
  - Urine crystals on prepuce, rectal prolapse
- Treatment:
  - Rarely medical, sometimes can be dissolved
  - Usually: penile amputation, perineal urethrostomy, urethrotomy
Rumen Acidosis

• Rapidly fermentable starch/sugar in excess
  – Lactic Acid = overproduced
  – Decline in rumen pH
  – pH promotes lactobacillus bacteria, make more LA
  – Leads to: dehydration, hypovolemic shock
    • Rumen imbalance, irritation
    • Bacteria and toxins can enter circulation
      – Systemic Acidosis

• Why?
  • Sudden changes in diet (amount, type, weather, etc.)
Rumen Acidosis

• Signs: 12-36 h after ingestion
  – Anorexia, depression, weakness,
  – Bloat, diarrhea, acute laminitis
  – Chronic: laminitis, foot abscesses, some neurological signs
    • Polioencephalomalacia

• Treatment:
  – Shock, dehydration, acidosis, toxemia, removal of feed
    • IV Sodium bicarbonate (5%), NSAIDS
      – Convert to roughage
      – Rumen transfaunation
      – Thiamine supplementation
Ration Balancing Software

• **OSU Ration Software:**
  http://agecon.okstate.edu/meatgoat/

• **Other software:**
  http://agecon.okstate.edu/meatgoat/record.asp

• **Https://msusheepration.montana.edu/**

• Brands (Iowa State)