Forage Inventory Considerations: Managing Now and Looking Ahead

Brought to you by:
K-State Beef Extension Team
What Should We Prepare For?

• Continued dry conditions
  • Limited production of winter annual forages for grazing
  • Likely low supplies of harvested forages
  • Delayed grass growth/production next spring and early summer
• High prices for feed commodities and forages
• Reduced water supplies in ponds, dams, springs
• Strong prices for bred females and feeder calves…?
KS Feeder Cattle Prices (Current vs. Last 5 Yrs)

Source: USDA & K-State Ag. Economics
Developing or Re-Evaluating Your Forage Plan

Key Points:

1) Know your herd inventory (accurately account for intake)
   # of head, weight, & projected inventory changes

2) Know your feed inventory (inventory of tonnage and quality)
   Baled hay, silage, co-products, grain

3) Calculate harvested forage needs if grazing is limited

4) Consider all your alternatives

5) Minimize any feed/forage shrink

6) Be flexible, remain calm, manage, look for opportunities
KSU Decision Support Tools

https://www.agmanager.info/hay-inventory-calculator

Drought Supplementation is Not Normal

• Normal supplementation program
  • Adequate supply low/moderate forage
    • Less than 7% CP
    • Protein 1st limiting

• Drought situation or limited grazing
  • Energy 1st limiting nutrient followed by protein
  • Replace forage with hay or fiber-based supplement
  • Feed combination supplements that supply both energy and protein
**BEEF COW SUPPLEMENT DECISION GUIDE**

Does each cow have all she can eat in the pasture?

**YES**
- Forage supply is adequate

**NO**
- Forage supply is inadequate; energy deficient
  - Reduce the forage needs of herd by lowering stocking rate and/or feeding supplement

What color is the forage?

**BROWN**
- Protein is likely <7% and limiting forage intake and digestion
  
**GREEN**
- No supplement
  - Protein is sufficient
  - Energy is sufficient

Are cows in adequate body condition (i.e., ≥4.5)?

**YES**
- Supplement with ≥32% CP
  - 0.1 to 0.3% BW/day
  - Improve rumen efficiency
  - Price $/lb CP

**NO**
- Supplement with 28-32% CP
  - 0.25 to 0.40% BW/day
  - Improve rumen efficiency
  - Provide extra energy
  - Consider $/lb CP and $/lb TDN

What color is the forage?

**GREEN**
- Supplement energy
  - with <28% CP
  - 0.4 to 0.8% BW/day
  - Protein is sufficient
  - Energy is deficient
  - Price $/lb TDN

**BROWN**
- Supplement with 28-28% CP
  - 0.3 to 0.5% BW/day
  - Energy is deficient
  - Protein is likely <7% and limiting forage digestion
    - Consider $/lb TDN and $/lb CP
  - If forage shortage is severe
    - Supplement with <20% CP
    - 0.4 to 0.8% BW/day
    - Price $/lb TDN

*This decision guide is a general tool and is not an accurate nor ensuring actual forage quality and quantity to develop a strategic supplementation program for a specific class of cattle.*

Mathis 2006
Supplement Delivery
“Rules of Thumb”

• Energy supplements
  • Daily or every other day

• Protein supplements < 30% CP
  • Daily or every other day

• Protein supplements > 30% CP
  • Infrequently as 1 time per week
Supplement Programs

• Based on the assumption that animals consume the supplement at the targeted amount
  • Forage quality
  • Supplement form/type
  • Delivery method
  • Social behaviors
Supplement Consumption
% non-eaters

- Supplement delivery method
  - Hand Fed = 5%
  - Self Fed = 19%

- Supplement type
  - Blocks = 14.3%
  - Dry Supplements = 15%
  - Liquid Supplements = 23.5%

Bowman and Sowell, 1997
## Supplementing pairs on bromegrass pastures (Warner et al., 2015)

<table>
<thead>
<tr>
<th></th>
<th>3.82 AUM/acre</th>
<th>2X with Supp</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cow ADG, lb</strong></td>
<td>0.42</td>
<td>0.62</td>
</tr>
<tr>
<td><strong>Calf ADG, lb</strong></td>
<td>2.27</td>
<td>2.37</td>
</tr>
<tr>
<td><strong>Grazed forage intake, lb DM/pair</strong></td>
<td>41.0</td>
<td>26.3</td>
</tr>
<tr>
<td><strong>Supplement intake, lb DM/pair</strong></td>
<td>--</td>
<td>15.7</td>
</tr>
<tr>
<td><strong>Total DMI, lb/pair</strong></td>
<td>41.0</td>
<td>42.0</td>
</tr>
</tbody>
</table>
Forage Challenges

Nitrate Accumulators

Barley  
Corn  
Flax  
Oats  
Radishes  
Rape  
Rye  
Soybeans  
Sugar beets  
Sweetclover  
Turnips  
wheat  

Canada Thistle  
Curly Dock  
Jimsonweed  
Kochia  
Lambsquarters  
Nightshade  
Pigweed  
Russian Thistle  
Smartweed  
Wild sunflower  

Sorghums  
Sorghum-sudans  
Sudan grass  
Millets  
Johnsongrass  

Prussic Acid

Common milkweed  
Wild cherry  
Black night shade  
Horsenettle  

SAFE  
Pearl millet  
Foxtail millet  
Corn
### Conditions of Concern

<table>
<thead>
<tr>
<th>Nitrates</th>
<th>Prussic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant stress</td>
<td>Plant stress</td>
</tr>
<tr>
<td>Drought</td>
<td>Drought</td>
</tr>
<tr>
<td>Drought breaking rain</td>
<td>Drought breaking rain</td>
</tr>
<tr>
<td>Hail</td>
<td>Hail</td>
</tr>
<tr>
<td>Frost</td>
<td>Frost/freeze</td>
</tr>
<tr>
<td>Soil Nitrogen</td>
<td></td>
</tr>
<tr>
<td>Soil fertility imbalance</td>
<td>Soil fertility imbalance</td>
</tr>
<tr>
<td>Regrowth/immature plants</td>
<td></td>
</tr>
<tr>
<td>Herbicide injury (?)</td>
<td></td>
</tr>
</tbody>
</table>
Symptoms

Nitrates
• Rapid/difficult/noisy breathing
• Rapid pulse
• Bluish mucus membranes
• Dark chocolate-colored blood
• Salivation
• Tremors, staggering, weakness
• Coma
• Abortion
• Death

Prussic Acid
• Rapid then slow labored breathing
• Muscle spasms
• Dilated pupils
• Bright cherry-red blood
• Death in 15 minutes to 2 hrs from asphyxiation
## Harvest considerations

<table>
<thead>
<tr>
<th>Item</th>
<th>Nitrate</th>
<th>Prussic Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant parts most</td>
<td>Base of plant</td>
<td>Young or new growth</td>
</tr>
<tr>
<td>affected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grazing problems</td>
<td>Rarely, unless forced to eat entire</td>
<td>Consumption of newest growth</td>
</tr>
<tr>
<td></td>
<td>stem, or very high levels</td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>Not impacted by drying</td>
<td>If very high, may remain dangerous after</td>
</tr>
<tr>
<td></td>
<td></td>
<td>drying</td>
</tr>
<tr>
<td>Silage</td>
<td>Reduces ~ 50%</td>
<td>Reduces ~ 50%</td>
</tr>
<tr>
<td>Green chop</td>
<td>High risk</td>
<td>Less risk than hay, not as safe as silage</td>
</tr>
</tbody>
</table>
Day zero represents dhurrin content before the frost occurred. The Garden City and Colby locations had another hard freeze between three and seven days.
Harvesting high nitrate forage

• Sample field prior to harvesting

• Options:
  – Allow plant to mature longer
  – Raise cutter bar (minimum of 6 inches)
  – Make into silage (if still moisture less than 40%)

Figure 1. Holman, J. 2010. Effect of cutting height on nitrate-N level in forage sorghum that was either stressed or severely drought-stressed within the same field near Garden City, Kansas, in 2010.
Harvesting high nitrate forage

• Ensiling process can reduce nitrates 40-60%  
  • IF DONE properly  
  • Still need to **test prior to feeding** for nitrate values

• Do not feed as green chop – unless feeding immediately  
  • Any heating will cause nitrate to convert to nitrite and is 10x more toxic to cattle
<table>
<thead>
<tr>
<th>Nitrate Map  (5 acres) ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>34,600</td>
</tr>
<tr>
<td>20,100</td>
</tr>
<tr>
<td>20,200</td>
</tr>
<tr>
<td>26,100</td>
</tr>
<tr>
<td>30,000</td>
</tr>
<tr>
<td>26,500</td>
</tr>
<tr>
<td>22,200</td>
</tr>
</tbody>
</table>

Hibbard et al., 1993
## General Guidelines On Prussic Acid

<table>
<thead>
<tr>
<th>ppm HCN (Dry Matter Basis)</th>
<th>Effect on cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-500</td>
<td>Generally safe, should not cause toxicity</td>
</tr>
<tr>
<td>500-1,000</td>
<td>Potentially toxic, should not be the only source of feed</td>
</tr>
<tr>
<td>$\geq$ 1,000</td>
<td>Dangerous to cattle and usually will cause death</td>
</tr>
</tbody>
</table>

- Don’t graze after a light frost or after rain during a prolonged drought
- Feed safe hay to cattle prior to turning out on suspected forages to graze
- Avoid grazing or green chopping young plants or new regrowth
- Test forages prior to feeding if levels are likely high at harvest
## General Guidelines On Nitrates

<table>
<thead>
<tr>
<th>NO₃ ppm DM Basis</th>
<th>Effect on Animals</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3,000</td>
<td>Generally safe, little risk</td>
<td></td>
</tr>
<tr>
<td>3,000-6,000</td>
<td>Moderately safe in most situations, limit to 50% of total ration for stressed animals</td>
<td></td>
</tr>
<tr>
<td>6,000-9,000</td>
<td>Potentially toxic depending on situation, should not be the only source of feed</td>
<td></td>
</tr>
<tr>
<td>≥ 9,000</td>
<td>Very dangerous, will often cause death</td>
<td></td>
</tr>
</tbody>
</table>

### Conversion factors for expressing nitrate content of forages

- Potassium Nitrate (KNO₃) $\times$ 0.61 = Nitrate (ppm NO₃)
- Nitrate Nitrogen (NO₃ N) $\times$ 4.42 = Nitrate (ppm NO₃)
- % Nitrate $\times$ 10,000 = Nitrate (ppm NO₃)
<table>
<thead>
<tr>
<th>Nitrate (NO₃), mg/L</th>
<th>Nitrate Nitrogen (NO₃ N), mg/L</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-44</td>
<td>0-10</td>
<td>Safe for consumption by ruminants</td>
</tr>
<tr>
<td>45-132</td>
<td>11-20</td>
<td>Generally safe in balanced diets with low-nitrate feeds</td>
</tr>
<tr>
<td>133-220</td>
<td>21-40</td>
<td>Could be harmful if consumed over long periods</td>
</tr>
<tr>
<td>221-660</td>
<td>41-100</td>
<td>Cattle at risk and possible death</td>
</tr>
<tr>
<td>≥661</td>
<td>≥101</td>
<td>Unsafe – possible death; should not be used as a source of water</td>
</tr>
</tbody>
</table>

Dilution is the solution to nitrate pollution
Health Concerns Following a Drought Year
Scenario

• Limited Forage through fall/winter
  • Stored forage for months
• Difficult to maintain Body Condition Score (BCS)
• How will this impact calf health and performance next spring??
Vitamin A

- Cattle convert beta carotene from green vegetation
- Stored in liver of cow for ~4 months
- Newborn calves obtain vitamin A through colostrum intake

<table>
<thead>
<tr>
<th></th>
<th>Colostrum</th>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit A (IU/100ml)</td>
<td>982</td>
<td>113</td>
</tr>
</tbody>
</table>
# Vitamin A deficiency in problem herds

<table>
<thead>
<tr>
<th>Sample</th>
<th>Number</th>
<th>Deficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum</td>
<td>368</td>
<td>95.1%</td>
</tr>
<tr>
<td>Liver</td>
<td>109</td>
<td>53.2%</td>
</tr>
</tbody>
</table>

Pregnant cows and/or newborn calves in problem herds

KSVDL: 2021
Vitamin A Deficiency

• Signs:
  • Reduced intake and growth, night blindness, edema, diarrhea, low conception rates, abortions, stillbirths, weak calves, abnormal development, impaired immune response
  • Essentially weak poor doing calves
## Serum Vitamin A Concentration and Health Outcomes

### Study Details
- n = 887

### Outcome Table

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Serum concentration ug/ml</th>
<th>Risk ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calf death</td>
<td>&gt; .225 (normal)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td></td>
<td>&lt; .14</td>
<td>2.90*</td>
<td>1.04-8.11</td>
</tr>
</tbody>
</table>
Cows need Vitamin A

• Consume 30,000-50,000 IU/hd/day
  • Supplement in feed/mineral
  • Does not have long shelf life. Will oxidize over time.
  • High nitrates in feed may interfere with absorption
• Injections available
  • Take to Veterinarian. Follow dosage recommendations
• Deficiencies need to be addressed prior to
Colostrum

- Calf is born with a functional but naïve immune system
  - Colostrum
    - Antibodies, fat, vitamins, and WBC
    - 10% BW by 24 hrs (~3-4L)
    - Absorption time limited
      - Closure starts at 6 hours
      - 50% by 9 hours
Ensure Good Immunity Transfer

• Healthy Cow
  • Age
  • Body Condition
    • 4 or below = poor quality/quantity colostrum
    • Immunity Status

• Easy Delivery

• Clean Environment
Effect of BCS on the immune system of calves?

Serum IgG, mg/dL

<table>
<thead>
<tr>
<th>Body Condition Score</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odde, 1997</td>
<td>1998</td>
<td>2179</td>
<td>2310</td>
<td>2349</td>
</tr>
</tbody>
</table>

Odde, 1997
Colostrum Management

Drs. Tom Wittum and Louis Perino
2-year study @ US-MARC

• 263 crossbred calves
• 23% had inadequate colostrum intake
Colostrum Management

Results of inadequate colostrum intake:

• Birth to weaning
  • 3X more likely to get sick
  • 6X more likely to get sick during first 28 days
  • 5X more likely to die
  • Weighed 35# less at weaning
Colostrum Management

Results of inadequate colostrum intake:

• Feedlot
  • 3X more likely to get sick
  • Gained 24# less over 242-day feeding period
Are you forced to calve in a different area??
Cold Stressed Calves

- Mild- (<100F)
- Severe- (<94F)
- Options??
  - Floorboard heater in pickup, heating lamps and blankets, warm water immersion (**warm slowly** to 100F/replace water frequently to keep temp), warming boxes, warm water IV Fluids
  - Can take 1-1.5 hrs to warm calves back to normal body temperature. **It takes time!!!**
Calf Health

• Scours:

• Costly due to poor performance, death, medical expense, and labor
Neonatal diarrhea (scours)

- **Bacteria**
  - *E. coli*
  - Salmonella
- **Viruses**
  - Rota
  - Corona
- **Protozoa**
  - Crypto
  - Coccidia

Most of these are on every cow-calf operation
Age when scouring

- **E. coli**: 1 day
- **Rota virus**: 10 days
- **Corona virus**: 15 days
- **Crypto**: 20 days
- **Salmonella**: 25 days
- **Coccidia**: 30 days

Days of age
2022 KSVDL Scour Submissions

% Pathogen and pathogen combinations in positive samples: 2022

- Salmonella: 0.7%
- E. coli: 0.7%
- Corona/Crypto: 1.4%
- Corona/Rota/Crypto: 2.1%
- Crypto/Rota: 2.8%
- Crypto: 11.7%
- Corona: 18.6%
- Corona/Rota: 25.5%
- Rota: 36.6%

Submissions: 246
Total tests: 1,510
Positive submissins: 126
Maintaining over winter will build suspension for your calves!

a. Conventionally multi-layered leaf spring with smoothly cut layer-ends. 14 layers; height of bundle: 140 mm; weight: 122 kg

b. Improved multi-layered leaf spring with pressed layer-ends and plastic layers in between. 9 layers; height of bundle: 127 mm; weight: 94 kg

c. Parabolic spring with pressed layer-ends (length approx. 1200 mm) and plastic layers in between. 3 layers; height of bundle: 64 mm; weight: 61 kg
Limit Feeding Systems for Backgrounding Cattle
Limit feeding

- Feeding practice since the 1980’s
- Improvements in feed efficiency
- No negative effects on health, improved morbidity detection
- Decreases in feed costs, waste removal, and expertise for bunk management
- Flexibility in commodity trading
- Less roughage and manure handling
- Decreased feed wastage
- Less labor, equipment and feeding expense
- Marketing

Loerch, 1990
Galyean et al., 1999
Spore et al., 2019
Limit Feeding

• Feeding a limited amount of a high-concentrate (high energy) ration to achieve a targeted weight gain for backgrounding cattle.

• Restricting cattle up to $\frac{3}{4}$ of ad libitum intake.
Limit Feeding

Low Roughage Inclusion

Improved Market Planning

Reduced manure output

Co-products "digestible fiber"

Improved Health Detection

Improved Feed Efficiency

Improved Health Detection

Improved Market Planning

Reduced manure output

Co-products "digestible fiber"

Improved Feed Efficiency

Improved Health Detection

Limit Feeding
## Effects of bunk allotment on performance of growing steers – KSU 2022

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment – Inches/animal</th>
<th>P-value³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td><strong>Body weight, Day 0</strong></td>
<td>472</td>
<td>475</td>
</tr>
<tr>
<td><strong>Body weight, Day 58</strong></td>
<td>566</td>
<td>572</td>
</tr>
<tr>
<td><strong>0 to 58</strong></td>
<td>1.61</td>
<td>1.67</td>
</tr>
<tr>
<td><strong>0 to 29</strong></td>
<td>1.79</td>
<td>1.94</td>
</tr>
<tr>
<td><strong>29 to 58</strong></td>
<td>1.44</td>
<td>1.41</td>
</tr>
<tr>
<td><strong>DMI, lb/day – 0 - 58</strong></td>
<td>9.74</td>
<td>9.73</td>
</tr>
<tr>
<td><strong>Feed:Gain, lb/lb – 0 - 58</strong></td>
<td>6.37</td>
<td>6.32</td>
</tr>
</tbody>
</table>
KSU Research Summary – 12 trials and ongoing

- Free-choice Low-energy Roughage-Based
- Restricted High-energy By-product-Based

Feeding strategy

G:F, kg/kg

- No adverse effects on health
- 27% improvement in efficiency
# Diets

<table>
<thead>
<tr>
<th>Intake level, % of <em>ad libitum</em></th>
<th>100</th>
<th>95</th>
<th>90</th>
<th>85</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mcal NEg/kg DM</td>
<td>0.99</td>
<td>1.10</td>
<td>1.21</td>
<td>1.32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>22.50</th>
<th>17.00</th>
<th>12.00</th>
<th>6.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prairie Hay</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry rolled corn</td>
<td>8.57</td>
<td>19.08</td>
<td>28.50</td>
<td>38.82</td>
</tr>
<tr>
<td>Sweet Bran</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Supplement</td>
<td>6.43</td>
<td>6.92</td>
<td>7.50</td>
<td>8.18</td>
</tr>
</tbody>
</table>

- Fed once daily, programmed to gain 2.2 lb/day
Limit Feeding Cows

• Decisions leading to limit feeding
  • Do I need to supply more than 50% of the diet
    • Remove cattle from the pasture to limit long-term damage
  • Compare the price of corn vs. the price of hay
    • Comparisons should be based on COST/Mcal NEm
    • Other feeds should be considered and compared

Byproduct feeds, other grains
• Distillers grains, corn gluten feed, soybean hulls, wheat midds
• Milo, wheat, barley
Limit-Feeding Programs For Cows

• Provide adequate bunk space (24-36”/hd).
• Cows will be discontent the first 7-14 days:
  • Appear gaunt, act hungry, and aggressive.
  • Will adjust and become settled if fed routinely.
• Be consistent!
  • Amount fed, time of feeding, feed placement and distribution.
• Sort cows by age.
• Include an ionophore in diet (except if horses are around).
• Grind forages to approx. 3” for stalks, cane hays.
• Typically lowers feed costs (depends on price).
### Example limit-fed diets for gestating beef cows.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa Hay</td>
<td>20.0</td>
<td></td>
<td></td>
<td>6.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Wheat Straw</td>
<td>13.0</td>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>WDGS</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn Silage</td>
<td></td>
<td></td>
<td></td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Whole Corn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10.7</td>
</tr>
<tr>
<td>Supplement</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>DMI, lb/day</strong></td>
<td>20.25</td>
<td>18.75</td>
<td>19.75</td>
<td>16.75</td>
<td></td>
</tr>
<tr>
<td><strong>TDN lb/day</strong></td>
<td>11.4</td>
<td>11.1</td>
<td>11.4</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td><strong>CP lb/day</strong></td>
<td>3.40</td>
<td>2.13</td>
<td>1.83</td>
<td>2.10</td>
<td></td>
</tr>
<tr>
<td><strong>$/cow/day</strong></td>
<td>1.61</td>
<td>1.43</td>
<td>1.44</td>
<td>1.60</td>
<td></td>
</tr>
</tbody>
</table>

Alfalfa hay = 85/ton, Straw = 60/ton, Corn Silage = 33.73/ton, Corn = 3.55/bu

WDGS = 44/ton, Supplement = 600/ton, Delivery = 5/ton, Grinding = 12/ton

Yardage = 0.40/cow/day
Performance of pregnant beef cows fed diets containing wheat straw treated 0.0%, 1.5% or 3.0% anhydrous ammonia (wt/wt basis) for 84 days

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>CON</th>
<th>1.5A</th>
<th>3.0A</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body Weight</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial, lbs</td>
<td></td>
<td>1265</td>
<td>1239</td>
<td>1245</td>
<td>16.6</td>
<td>0.51</td>
</tr>
<tr>
<td>Final, lbs</td>
<td></td>
<td>1395</td>
<td>1399</td>
<td>1408</td>
<td>19.6</td>
<td>0.89</td>
</tr>
<tr>
<td>Total Gain, lbs*</td>
<td></td>
<td>130</td>
<td>160</td>
<td>163</td>
<td>3.9</td>
<td>0.01</td>
</tr>
<tr>
<td>ADG, lb/d*</td>
<td></td>
<td>1.35</td>
<td>1.66</td>
<td>1.69</td>
<td>0.09</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>BCS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td></td>
<td>5.86</td>
<td>5.87</td>
<td>5.92</td>
<td>0.07</td>
<td>0.78</td>
</tr>
<tr>
<td>Final</td>
<td></td>
<td>5.86</td>
<td>5.94</td>
<td>6.08</td>
<td>0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td>0.00</td>
<td>0.08</td>
<td>0.16</td>
<td>0.04</td>
<td>0.13</td>
</tr>
</tbody>
</table>

*a,b Within a row, means without a common superscript differ (*P* ≤ 0.05)

*Linear *P* = 0.01, Quadratic *P* = 0.10
## Cost per Unit of Energy

<table>
<thead>
<tr>
<th>Item</th>
<th>AF Cost, $/ton</th>
<th>DM, %</th>
<th>NEm, Mcal/lb</th>
<th>Dry $/Mcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolled Corn$^1$</td>
<td>$281</td>
<td>85</td>
<td>1.00</td>
<td>0.17</td>
</tr>
<tr>
<td>Alfalfa Hay</td>
<td>$280</td>
<td>88</td>
<td>0.59</td>
<td>0.27</td>
</tr>
<tr>
<td>Sorghum Hay</td>
<td>$120</td>
<td>87</td>
<td>0.53</td>
<td>0.13</td>
</tr>
<tr>
<td>CRP Hay</td>
<td>$100</td>
<td>89</td>
<td>0.47</td>
<td>0.12</td>
</tr>
<tr>
<td>Dried Distillers Grain</td>
<td>$285</td>
<td>88</td>
<td>1.20</td>
<td>0.13</td>
</tr>
<tr>
<td>Corn Gluten Feed</td>
<td>$300</td>
<td>88</td>
<td>1.10</td>
<td>0.15</td>
</tr>
<tr>
<td>Wheat Midds</td>
<td>$275</td>
<td>89</td>
<td>0.92</td>
<td>0.17</td>
</tr>
</tbody>
</table>

$^1$ $7.60/bushel + $10/ton rolling and milling
## Cost per Unit of Protein

<table>
<thead>
<tr>
<th>Item</th>
<th>AF Cost,$/ton</th>
<th>DM, %</th>
<th>CP, %DM</th>
<th>Dry $/lb CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolled Corn(^1)</td>
<td>$281</td>
<td>85</td>
<td>10.0</td>
<td>1.65</td>
</tr>
<tr>
<td>Alfalfa Hay</td>
<td>$280</td>
<td>88</td>
<td>15.0</td>
<td>1.06</td>
</tr>
<tr>
<td>Sorghum Hay</td>
<td>$120</td>
<td>87</td>
<td>8.0</td>
<td>0.86</td>
</tr>
<tr>
<td>CRP Hay</td>
<td>$100</td>
<td>89</td>
<td>3.5</td>
<td>1.61</td>
</tr>
<tr>
<td>Dried Distillers Grain</td>
<td>$285</td>
<td>88</td>
<td>30.0</td>
<td>0.54</td>
</tr>
<tr>
<td>Corn Gluten Feed</td>
<td>$300</td>
<td>88</td>
<td>21.0</td>
<td>0.81</td>
</tr>
<tr>
<td>Wheat Midds</td>
<td>$275</td>
<td>89</td>
<td>18.0</td>
<td>0.86</td>
</tr>
</tbody>
</table>

\(^1\) $7.60/bushel + $10/ton rolling and milling
# Nutrient Value Failed Corn

<table>
<thead>
<tr>
<th>Item</th>
<th>Content (DM basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>27.4</td>
</tr>
<tr>
<td>Crude Protein, %</td>
<td>13.9</td>
</tr>
<tr>
<td>Acid Detergent Fiber, %</td>
<td>27.6</td>
</tr>
<tr>
<td>Neutral Detergent Fiber, %</td>
<td>48.5</td>
</tr>
<tr>
<td>Total Digestible Nutrients (TDN), %</td>
<td>71.6</td>
</tr>
<tr>
<td>Nitrate-N</td>
<td>1592</td>
</tr>
</tbody>
</table>
K-State Beef Extension Specialist Team

Dale Blasi
dblasi@ksu.edu

Jaymelynn Farney
jkj@ksu.edu

Sandy Johnson
sandyj@ksu.edu

A.J. Tarpoff
tarpoff@ksu.edu

Joel DeRouchey
jderouch@ksu.edu

Justin Waggoner
jwaggon@ksu.edu

Jason Warner
jasonwarner@ksu.edu
Enhancing the Value of Forages

Substitute treated residue for grain

By ALAN NEWMAN

It is not uncommon for livestock producers to consider using forage residue as a substitute for grain in their rations. However, using residue as a direct feedstock can be challenging due to the lack of energy and protein, as well as the presence of anti-nutritional factors. To overcome these challenges, a new technology called "ADM Second Crop" has been developed.

ADM Second Crop Feed Options

- **5%** Amount of feed replaced by Untreated Corn Stover
- **20%** Amount of feed replaced by Treated Corn Stover
- **60-80%** Amount of feed replaced by Treated Corn Stover + Distiller Grains

Treated corn stover can cut feed costs

By FRANK CLARK

Corn stover has been used as a feed source for livestock for many years. However, due to the high moisture content and low energy density, it is not always an efficient use of resources. The "Treated Corn Stover" technology has been developed to address these issues, allowing for a more effective and sustainable use of the stover.
Plant Cell Wall Components

- Lignin
  - hydrophobic and presents a barrier to water, enzymes, rumen microbes etc.
  - covalently bound to hemicellulose

Van Soest, 1984; Liyama et al., 1994
Alkali Treatment of Forage

• Disrupts the lignin-hemicellulose linkage
  improves microbial access

Figure 5. Remnants of wheat straw after 12 h ruminal digestion. Bars = 100 μm. (a) Control wheat stem shows cracks (△) through parenchyma (P) to sclerenchyma (S). (b) Ammoniated wheat stem shows eroded parenchyma (P) and partially exposed vascular tissue (V).

Harbers et al., 1982
1. Bales are stacked in a 3:2 or 3,2,1 arrangement in clean level location, free of debris (weeds etc.).

Anhydrous will effectively sterilize site.

2. Stack is covered with 6 mil, black plastic

3. Stack is sealed with at least 12 inches soil

4. Anhydrous ammonia is applied at 3% dry weight via pipe, inserted under plastic
Length of time stack needs to remained covered

<table>
<thead>
<tr>
<th>Temperature, °F</th>
<th>Weeks of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 40</td>
<td>8 plus</td>
</tr>
<tr>
<td>40-60</td>
<td>4 to 8</td>
</tr>
<tr>
<td>60-80</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Above 80</td>
<td>2</td>
</tr>
</tbody>
</table>

Keeping the plastic in one piece is the greatest challenge of ammoniating hay...treated during warmer temperatures is best
## Effect of Anhydrous Application Rate on Nutrient Composition

<table>
<thead>
<tr>
<th>Item, % DM</th>
<th>Pre</th>
<th>1.5%</th>
<th>3.0%</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein*</td>
<td>3.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>ADF</td>
<td>51.0</td>
<td>51.9</td>
<td>52.1</td>
<td>1.34</td>
<td>0.84</td>
</tr>
<tr>
<td>TDN</td>
<td>33.2</td>
<td>32.5</td>
<td>32.3</td>
<td>1.90</td>
<td>0.93</td>
</tr>
<tr>
<td>IVDMD†</td>
<td>31.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>46.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.60</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Est. TDN</td>
<td>39.6</td>
<td>47.8</td>
<td>50.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Treatment with 1.5 or 3.0% anhydrous ammonia dry basis

*Linear P > 0.01, Quadratic P = 0.02

<sup>a,b,c</sup>Within a row, means without a common superscript differ (P ≤ 0.10)

† Linear P > 0.01, Quadratic P = 0.10

Estimated TDN = 16.7 + (0.74*IVDMD)
Performance of pregnant beef cows fed diets containing wheat straw treated 0.0%, 1.5% or 3.0% anhydrous ammonia (wt/wt basis) for 84 days

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>CON</th>
<th>1.5A</th>
<th>3.0A</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial, lbs</td>
<td></td>
<td>1265</td>
<td>1239</td>
<td>1245</td>
<td>16.6</td>
<td>0.51</td>
</tr>
<tr>
<td>Final, lbs</td>
<td></td>
<td>1395</td>
<td>1399</td>
<td>1408</td>
<td>19.6</td>
<td>0.89</td>
</tr>
<tr>
<td>Total Gain, lbs*</td>
<td></td>
<td>130</td>
<td>160</td>
<td>163</td>
<td>3.9</td>
<td>0.01</td>
</tr>
<tr>
<td>ADG, lb/d*</td>
<td></td>
<td>1.35</td>
<td>1.66</td>
<td>1.69</td>
<td>0.09</td>
<td>0.01</td>
</tr>
<tr>
<td>BCS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td></td>
<td>5.86</td>
<td>5.87</td>
<td>5.92</td>
<td>0.07</td>
<td>0.78</td>
</tr>
<tr>
<td>Final</td>
<td></td>
<td>5.86</td>
<td>5.94</td>
<td>6.08</td>
<td>0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td>0.00</td>
<td>0.08</td>
<td>0.16</td>
<td>0.04</td>
<td>0.13</td>
</tr>
</tbody>
</table>

*a,b Within a row, means without a common superscript differ (P ≤ 0.05)
*Linear P = 0.01, Quadratic P = 0.10
Effects of anhydrous ammonia on wheat straw nutrient composition (Waggoner et al., 2014)

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-Treat</th>
<th>1.5%</th>
<th>3.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of NH$_3$ applied/ton of forage$^1$</td>
<td>$0.00</td>
<td>$21.00</td>
<td>$42.00</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>3.3</td>
<td>8.6</td>
<td>10.8</td>
</tr>
<tr>
<td>Cost per lb of CP added</td>
<td>-</td>
<td>$0.198</td>
<td>$0.280</td>
</tr>
<tr>
<td>IVDMD, %</td>
<td>31.0</td>
<td>42.0</td>
<td>46.2</td>
</tr>
<tr>
<td>Cost per lb of IVDMD added</td>
<td>-</td>
<td>$0.095</td>
<td>$0.138</td>
</tr>
</tbody>
</table>

$^1$Assuming $1400/ton NH$_3$
Effects of anhydrous ammonia on wheat straw nutrient composition (Waggoner et al., 2014)

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-Treat</th>
<th>Ammoniation Rate&lt;sup&gt;1&lt;/sup&gt;</th>
<th>SEM</th>
<th>P - value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.5%</td>
<td>3.0%</td>
<td></td>
</tr>
<tr>
<td>Dry matter, %</td>
<td>92.1</td>
<td>91.0</td>
<td>91.1</td>
<td>1.01</td>
</tr>
<tr>
<td>Crude protein, %&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.3</td>
<td>8.6</td>
<td>10.8</td>
<td>0.50</td>
</tr>
<tr>
<td>Acid detergent fiber, %</td>
<td>51.0</td>
<td>51.9</td>
<td>52.1</td>
<td>1.34</td>
</tr>
<tr>
<td>TDN, %</td>
<td>33.2</td>
<td>32.5</td>
<td>32.3</td>
<td>1.90</td>
</tr>
<tr>
<td>IVDMD, %&lt;sup&gt;3&lt;/sup&gt;</td>
<td>31.0</td>
<td>42.0</td>
<td>46.2</td>
<td>1.60</td>
</tr>
</tbody>
</table>

<sup>1</sup>Treatment with 1.5% (HALF) or 3.0% (FULL) of anhydrous ammonia on a dry weight basis.

<sup>2</sup>Linear effect, $P \leq 0.01$; quadratic effect, $P = 0.02$.

<sup>3</sup>In vitro dry matter disappearance; linear effect, $P \leq 0.01$; quadratic effect, $P = 0.10$. 