Alfalfa - Haylage in a Day?

Paul A. Porter, Ph.D.
Bill Mahanna, Ph.D., Dipl ACAN
Pioneer Hi-Bred Int'l
paul.porter@pioneer.com

SURVIVAL
When you are in deep trouble, say nothing, and try to look like you know what you're doing.
Genetic variation in alfalfa feeding quality is small compared to corn silage.

Harvest timing and growing environment exert a large influence on alfalfa quality.
- Quality is a function of both fiber digestibility (NDFD) and protein.
- Protein can be salvaged simply by preventing leaf loss during harvest.

Environmental Effects
- Smaller effect on quality than on yield.
- Most factors that limit plant development tend to promote higher quality (lack of water, cold weather, plant diseases).
  - Greatest effect on less stem and more leaf, hence quality higher.
- Biggest factors are:
  - temperature
  - water deficiency
  - solar radiation
  - And a distant fourth, soil fertility.
Environmental Influences on Alfalfa

(we still have to put up with climate effects!)

- Long day lengths, cool nights and moderately dry weather promotes the highest digestibility alfalfa
- Warm, wet weather promotes the poorest quality alfalfa
- Cool, wet growing conditions produce high quality alfalfa due to low NDF and low lignification ...
  (if you can get it harvested)


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- Wet
  - cloudy weather reduces light, reducing photosynthesis
  - higher water availability promotes mobilization of sugar into plant cell wall and lignin
  - cloudy weather promotes low sugar
  - delayed harvest resulting in higher fiber, lower CP.
  - potential for rained-on forages w/ high respiration & leaching losses.
  - potential for more molds/ spoilage from increased exposure to soil-borne fungi and bacteria.

**RFV vs. RFQ**  
**Alfalfa Example**

<table>
<thead>
<tr>
<th>Sample</th>
<th>ADF (% DM)</th>
<th>NDF (% DM)</th>
<th>NDFD (% NDF)</th>
<th>RFV</th>
<th>RFQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
<td>43</td>
<td>48</td>
<td>135</td>
<td>148</td>
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<tr>
<td>2</td>
<td>34</td>
<td>43</td>
<td>58</td>
<td>135</td>
<td>174</td>
</tr>
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</table>

Even the best Haylage has a hard time beating Corn Silage NDFD.

**NDFD Summaries**  
**Dairyland Laboratories**

<table>
<thead>
<tr>
<th>Forage Crop</th>
<th>Average</th>
<th>Range</th>
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<tbody>
<tr>
<td>Mixed Hay</td>
<td>47</td>
<td>32-62</td>
</tr>
<tr>
<td>Legume Hay</td>
<td>46</td>
<td>32-61</td>
</tr>
<tr>
<td>Grass Hay</td>
<td>55</td>
<td>38-73</td>
</tr>
<tr>
<td>Mixed Haylage</td>
<td>42</td>
<td>25-60</td>
</tr>
<tr>
<td>Legume Haylage</td>
<td>42</td>
<td>25-58</td>
</tr>
<tr>
<td>Grass Haylage</td>
<td>61</td>
<td>51-72</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>60</td>
<td>48-71</td>
</tr>
</tbody>
</table>
Monitor closely and set targets

- **Utilizing Results**
  - **Set Harvest Goals**
    - 150-170 RFQ for milk cows
    - 120-130 RFQ for other cattle
  - **Adjust for Field Loss**
    - expect 10% loss
    - cut at 165-170 RFQ
    - harvested forage will be 150 RFQ
  - **Adjust for Harvest Time**
    - 1 day = 3-4 RFQ units
  - **Adjust for Field Conditions**
    - soil type
    - drainage

- **Each day delay in harvest can:**
  - ↓ CP .1% points
  - ↑ ADF .7% points
  - ↑ NDF 1% points
  - ↓ RFQ 4 points

- **Storage Implications**
  - Inconsistency
  - Shrink/spoilage
  - Clostridia if too wet
  - Aerobic stability/heating

Remember that field-based quality methods are on fresh alfalfa... fiber levels will be higher in fermented silage... sugars will be lowered and fiber concentrated by 5-35% depending upon the quality of the fermentation.

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**Cut hay or plant corn?**

- Delaying harvesting one day can cause an average drop of 4 RFV points at $1.00 cents per point of RFV results in a loss of $4.00/ton. If harvest weights average 4 ton per acre (on first cutting) then the loss is $16.00 per acre per day.

- If corn yield loss is 1 bushel/day after May 10 and 2-3 bu/day after end of May (in the corn belt, losses greater in N. growing environments) then the loss is a minimum of $8--$12.00 per day per acre.

- At this rate if would be better to harvest high quality hay for top end cows then plant corn.
Predictive Equations for Alfalfa Quality

1. In a 2 X 2 foot area, find the **tallest** stem (may not be the most mature)
2. In the same 2 X 2 foot area, find the **most mature** stem (may not be the tallest)

**Here the most mature stem is in the bud stage, so the bud side is used.**

Tallest stem is used to estimate **Relative Feed Value** (RFV).

Measure to the tip of the stem, not the tip of the tallest leaf.

Here the RFV is about 226.
Do Modern Forage Harvesting Equipment Add Soilborne Microbes?

- Sickle vs. disk mower-conditioner
  - No difference (8.7 vs. 8.8% ash) in WI soils without varmint infestations
    - No difference in yield (1.51 vs. 1.46 ton DM/acre)
  - 12.8 vs. 14.6% ash in UT fine and dry soils with varmint problems.
- Diskbine set up dictates how much soil contamination
  - Shouldn’t be harvesting close to the ground
  - Poorer quality forage is at bottom of stem anyway
- Mergers
  - Wheel rakes: 9.7% ash
  - Rotary rakes and mergers: same at ~8.5% ash
  - Mergers keep rocks out of windrow

Source: Kevin Shinners, UW 2005

Potential Pitfalls of Cutting Too Low

Three windrow treatments in a field where the disc-mower was run low enough, putting dirt in the windrow

- Do disk mowers actually vacuum up soil debris, spores etc into the feed??
- Impact of soil-borne bacteria and spores on silage fermentation can be immense.
- Seeing more clostridial silage in haylages < 70% moisture (traditional safe zone)

<table>
<thead>
<tr>
<th>Method</th>
<th>Ash (% DM)</th>
<th>Iron (PPM)</th>
<th>Silica Est. (% ash)</th>
<th>NE-L</th>
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</thead>
<tbody>
<tr>
<td>Old Rake</td>
<td>15.2</td>
<td>138</td>
<td>69</td>
<td>.607</td>
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<tr>
<td>New Rake</td>
<td>12.2</td>
<td>518</td>
<td>53</td>
<td>.636</td>
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<tr>
<td>No Rake</td>
<td>14.2</td>
<td>316</td>
<td>56</td>
<td>.616</td>
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<tr>
<td>“Book Value”</td>
<td>8.6</td>
<td>253</td>
<td>43</td>
<td>.670</td>
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</table>

Recommendations
- Despite the potential yield boost, stay with 3” stubble
- Avoid dirt when raking/merging
- Apply manure at least 3 weeks before mowing

Source: Cargill Dairy Report – Kurt Ruppel: Vol2, No 3, 5/13/02
Harvest Moisture

**Too Wet**
- Clostridial Activity
- Excessive Nutrient Losses
- Forage Inconsistency

**Too Dry**
- Mold and Yeast Activity
- Excessive Nutrient Losses
- High Ash Content
- Forage Inconsistency

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**Biology of Alfalfa Drying**

80% Initial Phase

Intermediate Phase

Final Phase

Source: Tom Kilcer - Cornell Cooperative Extension in Rensselaer County
And Steve Hadcock - Cornell Cooperative Extension in Columbia County
Biology of Drying Alfalfa

Stomatal openings account for most of the moisture loss to get to typical starting silage moistures

Axial moisture movement through stem to leaves and out through stomata

Moisture

Time

80%

70%

20%

Biology of Alfalfa Drying

Axial moisture movement through stem to leaves and out through stomata

moisture moves out of the leaf stomata and draws moisture from the petioles which draws moisture from the stem and draws air into the cut end drying the plant.

- 30% of water removed before stomata close
- Removes 30% of the water from the stem (grass)
- 35% of alfalfa stem moisture exits through the leaf
- Legumes 10X more stomata than grass
- During sunlight stomata stay open.... but shading in a narrow, dense windrow closes all but the exposed stomata

Source: Tom Kilcer- Cornell Cooperative Extension in Rensselaer County
And Steve Hadcock - Cornell Cooperative Extension in Columbia County
There is a misconception that leaves dry primarily through their surface but the surface is covered with a waxy layer to prevent moisture loss. When guard cells are full, they produce an opening for moisture and oxygen to escape. When they are in the dark or wilted, they close stopping the moisture loss.

The stomata have air spaces that are lined with cells that do not have a waxy layer so easily lose moisture as long as guard cells stay open.

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Drying Reduced
10 – 100X
in narrow, dense windrow with stomata closed

Harris & Tullberg 1980

Source: Tom Kilcer- Cornell Cooperative Extension In Rensselaer County
And Steve Hadcock- Cornell Cooperative Extension in Columbia County
The slower intermediate drying stage involves radial moisture movement from the center of the stem to the outer edge. This is where "crop conditioning" plays a critical role in helping dry forages.

The effectiveness of both of these stages is significantly influenced by windrow density and width.
Biology of Alfalfa Drying

The final drying stage is influenced by osmotic and cell forces influenced primarily by environmental drying conditions and soil moistures.

Physics of Moisture Loss
(What Helps or Hurts Hay Drying)

- Soil Moisture
- Swath Density
- Relative Humidity

These speed drying
These slow drying

Source: Tom Kilcer - Cornell Cooperative Extension in Rensselaer County
And Steve Hadcock - Cornell Cooperative Extension in Columbia County
Wide swathing to make haylage in a day in NY

- Mow alfalfa into a wide swath (conditioners removed) so that it dries faster, then merge it and chop it all within the same 24 hours.
  - allows the dairy to mow around a weather forecast, if it is going to rain there is no haylage on the ground, removes most of the risk of playing the weather game.
  - less worry about wet forages by having to harvest forages before they are dry to beat a rain storm.
  - If anything, watch out for getting it too dry
- Preserves quality by retaining more sugars and protein (in the protein/peptide form, rather than ammonia-N)

Wide Swathing

- Faster drying – possibility of "haylage-in-a-day"
- Saves sugars for better fermentation
- More energy reaches the cow’s mouth
- Reduces soluble protein
- About ~13% more milk/ton of forage produced
Biology of Alfalfa Drying

The amount of sunlight hitting the swath is the #1 POSITIVE FACTOR in accelerating drying of forages.

3 X more sunlight

Source: Tom Kilcer - Cornell Cooperative Extension in Rensselaer County
And Steve Hadcock - Cornell Cooperative Extension in Columbia County

Swath = 90% of Cut Width

40% of Cut Width
Width Matters More Than Conditioning – Alfalfa- Swath Not Moved

Increasing width of swath continues to photosynthesize and add dry matter in the form of sugars

Produced by Cornell Cooperative Extension of Rensselaer County
To condition or not??

- Cornell research (Kilcer) summarized in a 2005 Hoard's article indicating conditioning is of **no** benefit when employing wide swathing management.
  - Created much discussion since conditioning is an accepted practice.

- UW researchers (Shinners and Schuler) put things into perspective in a 2006 Hoards article.

**Bottom-line:** alfalfa should still be conditioned, but that most of the wilting is physiological through stomata openings from fresh cut down to 70% moisture. Then after that the effects of conditioning kick in.
To condition or not??

- If wide-swathing, conditioning not as important to get down to ~60% moisture for ensiling
- If not adequately wide-swathing, due to machine limitations, conditioning is essential

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>Swath Adjustment</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Maximum</td>
<td>48.3</td>
<td>27.8</td>
<td>65.3</td>
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<tr>
<td>Conditioner Width</td>
<td>52.0</td>
<td>29.4</td>
<td>73.3</td>
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<tr>
<td>Wheel Spacing</td>
<td>57.7</td>
<td>43.7</td>
<td>76.2</td>
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</table>

Haylage in a Day Summary

- Swath width is the most critical factor for rapid drying
- Conditioning still important if not wide swath
  - How wide is wide?
- Take care to minimize dirt contamination
- What about PM cutting to maximize sugar?
Nutritional Changes That Occur When Alfalfa Forage Ferments to Silage

### NUTRITIONAL

<table>
<thead>
<tr>
<th></th>
<th>Fresh</th>
<th>Ensiled</th>
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<tbody>
<tr>
<td>Moisture, % DM</td>
<td>53.3</td>
<td>55.3</td>
</tr>
<tr>
<td>Dry Matter, % DM</td>
<td>46.7</td>
<td>44.7</td>
</tr>
<tr>
<td>Crude Protein, % DM</td>
<td>24.8</td>
<td>24.8</td>
</tr>
<tr>
<td>Bound Protein, % DM</td>
<td>7.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Soluble Protein, % TN</td>
<td>30.0</td>
<td>90.0</td>
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<tr>
<td>NE-L, (mcal/% DM)</td>
<td>0.69</td>
<td>0.68</td>
</tr>
<tr>
<td>NE-G, (mcal/% DM)</td>
<td>0.44</td>
<td>0.41</td>
</tr>
<tr>
<td>ADF, % DM</td>
<td>29.4</td>
<td>30.7</td>
</tr>
<tr>
<td>NDF, % DM</td>
<td>36.4</td>
<td>36.2</td>
</tr>
<tr>
<td>Ash, % DM</td>
<td>11.4</td>
<td>11.5</td>
</tr>
<tr>
<td>Starch, % DM</td>
<td>1.3</td>
<td>1.1</td>
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<tr>
<td>Sugar, % DM</td>
<td>10.1</td>
<td>6.5</td>
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<tr>
<td>WSC, % DM</td>
<td>11.4</td>
<td>5.9</td>
</tr>
<tr>
<td>NFC, % DM</td>
<td>25.9</td>
<td>25.9</td>
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<tr>
<td>RFV</td>
<td>166.1</td>
<td>167.1</td>
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### FERMENTATION

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<tbody>
<tr>
<td>pH</td>
<td>5.9</td>
<td>4.5</td>
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<tr>
<td>Lactic Acid, % DM</td>
<td>0.0</td>
<td>5.8</td>
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<tr>
<td>Acetic Acid, % DM</td>
<td>0.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Propionic Acid, % DM</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Butyric Acid, % DM</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Ammonia Nitrogen, % CP</td>
<td>1.3</td>
<td>3.5</td>
</tr>
</tbody>
</table>

- Occurs during the initial phase of the ensiling process
- Proteolytic enzymes are still active during this phase
- Protein degradation process causes increased soluble protein levels.
- Ration balancing considerations:
  - high nitrogen pool in rumen
  - requires higher levels of fermentable carbohydrate for production of microbial protein
  - Monitoring tool: Blood and/or milk urea nitrogen (BUN, MUN)

Protein Nutrition....Definitions

String of pearls = Protein

Several pearls = Peptide

1 Pearl = Amino Acid

Sand grains = Ammonia-Nitrogen
Increased soluble protein during the ensiling process is not good for the environment or for the cow’s energy status

- Cows recycle more nitrogen than previously thought
- Excess ration N costs the cow energy by having to excrete excess urea

EXAMINING NITROGEN EFFICIENCIES IN LACTATING DAIRY CATTLE USING CORN SILAGE BASED DIETS

E. B. Recktenwald and M. E. Van Amburgh

INTRODUCTION

The topic of nitrogen (N) efficiency has gained considerable popularity in recent years due to environmental concern over N emissions, and the existing governmental regulations. Agriculture contributes to this problem by adding nitrogen to both the atmosphere and surface water. In the air, nitrogen oxides can aid in the formation of ozone and particulate matter, and can cause a variety of respiratory illnesses and contribute to the formation of acid rain. In the U.S., 50% of total ammonia emissions and 25% of nitrous oxide emissions are from animals and nitrous oxide has been implicated as a significant contributor to global warming, having a 310 time more harmful mass-specific effect than CO2 as a global warming agent (NAP, 2003). Nitrogen can also be found in water supplies, either directly by runoff or indirectly through atmospheric deposition. According to the EPA, in 1997, over a million tons of nitrogen leached into surface waters in the north-central region of the U.S. (US EPA, 2002).
Alfalfa Silage: Likely the Most Variable Feed on the Dairy......

- Some dairies chose to grow enough alfalfa for rotation needs then buy the remainder as hay so they can identity preserve it to:
  - sort by quality (or bag haylage)
  - reduce ration variability

- Field-by-field variation in
  - age of stand (grass content)
  - maturity
  - moisture
  - fermentation & palatability
    - soil spore contamination from chopping too short (<3” stubble), merging windrows, disk binds?
    - High Fe interferes with Cu, Zn and Mo important to foot health
    - manure application?

- High Fe interferes with Cu, Zn and Mo important to foot health
- Manure application?
- Interface between excessively wet haylage on bottom and too dry on top

**AMMONIA NITROGEN AS A PERCENTAGE OF TOTAL NITROGEN**

**THREE TRIAL SUMMARY – PIONEER LIVESTOCK NUTRITION CENTER**

<table>
<thead>
<tr>
<th></th>
<th>CONTROL</th>
<th>1174</th>
<th>11H50</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Ammonia nitrogen as a percentage of total nitrogen</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Economic Significance**: According to the CPM-Dairy Ration Evaluation and Formulation Model (CPM Ver 1.0), reducing ammonia-nitrogen lowers energy expenditure by reducing the excretion of excessive non-protein nitrogen (termed urea cost in the model). Assuming 10 lbs. of alfalfa silage dry matter intake/day, 11H50 treated silage compared to control silage had an energy-sparing effect from reduced urea cost equal to .042 Mcal NE Energy of Lactation. This .042 Mcal NE-L equates to the energy in 33.7 bushels of corn or the energy to produce 8 lbs. more milk in every ton of alfalfa silage treated with 11H50.
Managing Clostridial Haylage

What happens in a butyric fermentation?

- Clostridia are present in the soil
- Can not tolerate acid conditions
  - optimum growth in pH range 7.0-7.4
  - sufficient quantities of lactic acid inhibit their growth
    (unless they are lactate-utilizers:
    C. butyricum, C. paraputrificum, C. tyrobutyricum)
- Prefer wet silage (>65% moisture)
- Legume crops are more likely to have problems
  - highly buffered
  - Relatively low in water soluble carbohydrates
    especially if slowly cured or rained-on
What happens in a butyric fermentation?

- Wet crop (> 65%) in which inhibitory pH not reached (~ 4.8)
- Lactic acid converted to butyric acid
  - pH of silage increases
- Fermentation of amino acids
  - Deamination - NH3 released, organic acid residue
  - Decarboxylation - amine formation
  - Oxidation/reduction reactions of amino acids
    - NH3 is released

Source: B. Stone, Cornell Nutrition Conference, 2004

Clostridial Silages
(secondary fermentation)

Physical signs
- Odor - reeks
- Color - greenish
- Feel - wet, slimy

Laboratory signs
- Dry matter <32%
- pH > 5
- Butyrate > .1% (1 - 4 common)
- Ammonia N > 10% of CP

Source: B. Stone, Cornell Nutrition Conference, 2004
Typical Secondary Clostridial Fermentation In Alfalfa

<table>
<thead>
<tr>
<th>Bunker Silos</th>
<th>Normal Values</th>
<th>Good Silage</th>
<th>Clostridial Silage</th>
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<tbody>
<tr>
<td><strong>NUTRITIONAL</strong></td>
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<tr>
<td>Moisture</td>
<td>63-70</td>
<td>67.3</td>
<td>77.3</td>
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<tr>
<td>Dry Matter</td>
<td>30-35</td>
<td>32.7</td>
<td>22.7</td>
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<tr>
<td>Ash, %DM</td>
<td>&lt; 0.1</td>
<td>12.0</td>
<td>17.0</td>
</tr>
<tr>
<td>RFV (alfalfa only)</td>
<td>160</td>
<td>206</td>
<td>139</td>
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<tr>
<td><strong>FERMENTATION</strong></td>
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<tr>
<td>pH</td>
<td>&lt; 4.5</td>
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<td>6.3</td>
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<tr>
<td>Lactic Acid %DM</td>
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<td>5.7</td>
<td>0</td>
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<tr>
<td>Acetic Acid% DM</td>
<td>&lt; 2.0</td>
<td>3.6</td>
<td>6.3</td>
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<tr>
<td>Propionic Acid% DM</td>
<td>&lt; 1.0</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>Butyric Acid, % DM</td>
<td>&lt; 0.1</td>
<td>0</td>
<td>8.4</td>
</tr>
<tr>
<td>Ammonia Nitrogen, % CP</td>
<td>&lt; 10-15%</td>
<td>10.8</td>
<td>51.6</td>
</tr>
</tbody>
</table>

Source: Bill Seglar, Pioneer Hi-Bred

"Venting Off" Undesirable Silage VFA’s by “mismanaging” the silage face
(e.g. knocking down and aerate - remember, butyric silages will not heat)

- Case Study Example:
  - 16 lbs of clostridial haylage DM/cow/day in TMR
    - 3.2% butyric acid on haylage taken from face of the bunker = 323 g/c/d intake
    - After loosening face and left in pile for 24 hours haylage now 2.1% butyric acid = 152 g/c/d intake
    - After mixing in TMR for one hour haylage now 1.8% butyric = 130g/c/d intake
      - Watch this method if relying heavily on haylage for peNDF
  - Only way to get to 50 gm/c/d intakes or less is to reduce inclusion rate of haylage in TMR

Summary of reasons to keep clostridial silage away from (transition) cows

- Likely reduction in DMI
- No water soluble carbohydrates
- Loss of amino acids
- Increase in blood ketones

Source: B. Stone, Cornell Nutrition Conference, 2004

Ketosis Associated with Butyric Acid Intake

Source: Andersson and Lundstrom 1985
Butyric Acid Dose Calculator
(Where VFA Analysis Does Have Merit)

<table>
<thead>
<tr>
<th>Butyric acid levels (% DM)</th>
<th>50 grams</th>
<th>150 grams</th>
<th>250 grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>1.1</td>
<td>44.1</td>
<td>132.2</td>
</tr>
<tr>
<td>0.50</td>
<td>2.3</td>
<td>22.0</td>
<td>66.1</td>
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<tr>
<td>0.75</td>
<td>3.4</td>
<td>14.7</td>
<td>44.1</td>
</tr>
<tr>
<td>1.00</td>
<td>4.5</td>
<td>11.0</td>
<td>33.0</td>
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<tr>
<td>1.25</td>
<td>5.7</td>
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Butyric acid concentrations and pounds of silage DM intake to reach butyric acid doses of:
• 50 grams – reduced DM intake and risk of ketosis to early lactation cows
• 150 grams – high risk of ketosis in early lactation cows
• 250 grams – high risk of ketosis in all lactating cows

Management approaches to avoid Clostridial fermentations

- Harvest at the appropriate DM (34 – 44% DM)
- Maximize sugar level at time of ensiling
  - cut after several sunny days (!)
  - enhance dry-down time wide windrows
- Minimize soil contamination of the crop
- Minimize the aerobic phase (packing)
- Inoculate (provide a dominant lactic acid fermentation)

Source: Dairyland Laboratories, Inc. 12/2000 and Gary Oetzel, DVM – University of Wisconsin

Source: B. Stone, Cornell Nutrition Conference, 2004
Choosing a quality inoculant

- Does the company do basic product research?
  Do they have proprietary products?
  Do they buy back unused product?
  Do they assist with reliable applicator technology?
  Do they provide animal performance data?
  Do they provide field support?

- Are the products crop specific?
  Are the products stable during summer application?
  Can they be frozen after mixed?
    - Used w/ chlorinated water?
    - Sold in Canada?

- Remember, a quality inoculant works best with above average management.

Pioneer is committed to testing our products through animals at the Pioneer Livestock Nutrition Center