Making Grass Silage

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# Fermentation analysis profile

<table>
<thead>
<tr>
<th></th>
<th>Legume Silage</th>
<th>Grass Silage</th>
<th>Corn Silage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moisture:</strong></td>
<td>65%+</td>
<td>&lt;65%</td>
<td>60-65%</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>4.0-4.3</td>
<td>4.3-4.7</td>
<td>3.8-4.2</td>
</tr>
<tr>
<td><strong>Lactic Acid</strong></td>
<td>6.0-8.0</td>
<td>6.0-10.0</td>
<td>5.0-10.0</td>
</tr>
<tr>
<td><strong>Acetic Acid</strong></td>
<td>1.0-3.0</td>
<td>1.0-3.0</td>
<td>1.0-3.0</td>
</tr>
<tr>
<td><strong>Ethanol (% of DM)</strong></td>
<td>&lt;1.0</td>
<td>&lt;1.0</td>
<td>&lt;3.0</td>
</tr>
<tr>
<td><strong>Ammonia-N (% of CP)</strong></td>
<td>&lt;15.0</td>
<td>&lt;12.0</td>
<td>&lt;8.0</td>
</tr>
<tr>
<td><strong>Lactic: Acetic ratio</strong></td>
<td>2+</td>
<td>2+</td>
<td>3+</td>
</tr>
<tr>
<td><strong>Lactic (% of total acids)</strong></td>
<td>60+</td>
<td>60+</td>
<td>70+</td>
</tr>
</tbody>
</table>
High quality grass silage results from:

1. Harvesting high quality forage
2. Inoculation
3. Proper packing
4. Covering
Making Good Grass Silage

- Want 10–15% WSC (sugars) in the dry matter
  - Young, leafy grass that has been well fertilized, grass/clover mixtures and autumn cuts tend to have low sugar levels
- Buffering capacity is directly related to how much sugar it takes to lower silage pH.
  - Grass typically has a low buffering capacity and an adequate supply of sugars
  - High rates of N increase buffering capacity.
Grass Dry Matter Digestibility

Leaf stage | Boot stage | Heading | Full flower

Digestible DM
Indigestible DM
Recommended harvest
Cool Season Grasses Head only on first Cutting

Harvest 1\textsuperscript{st} cutting at boot stage

2\textsuperscript{nd} and later cuttings are primarily leaves

Boot stage

Heading
Mowing, Conditioning

- Mowing height - 3.5 to 4 inches
  - Promotes rapid grass regrowth
  - Reduces dirt contamination
- Condition with flail conditioner
- Make wide swath
- Tedding may be necessary
- Rake/merge
Chopping

- Chop at 60 to 65% moisture
- Cut length $\frac{3}{4}$ to 1 inches
  - Longer makes compaction more difficult
    - Good compaction - Faster acid fermentation
    - Good compaction - Less spoilage on feedout
  - Improved feed uptake
- Apply inoculant
Precutting forage before baling

- Cutting forage for hay/haylage - bales that break apart easily for feeding
  - Bale is more dense
  - Bales break apart easier for use in TMR
  - Higher feeding efficiency
  - Improved stocker cattle gain
Different Types of Inoculants

- Traditional homofermentative types:
  - *Lactobacillus plantarum*, *L. casei*, *Pediococcus* species, *Enterococcus faecium*
  - *Lactobacillus buchneri*, a heterofermenter
  - Combination of homofermenters with *L. buchneri*
Homofermenter vs. Heterofermenter

- **Homofermenter** (*L. planatarium*)
  1 6-C Sugar $\rightarrow$ 2 Lactic Acid

- **Heterofermenter** (*L. buchneri*)
  1 6-C Sugar $\rightarrow$ 1 Lactic Acid + 1 Acetic Acid + CO₂
  1 6-C Sugar $\rightarrow$ 1 Lactic Acid + 1 Ethanol + CO₂
  1 Lactic Acid $\rightarrow$ 1 Acetic Acid + CO₂ (*L. buchneri*, not all heteros)
End Product Comparison

- **Lactic acid** - strong acid; weak spoilage inhibitor; fermented in rumen
- **Acetic acid** - weak acid; good spoilage inhibitor; not fermented in rumen
- **Ethanol** - neutral; poor spoilage inhibitor; partially fermented in rumen
- **Carbon dioxide** - lost dry matter
So…

- If you want to preserve crop quality:
  - Lactic acid
- If you want a silage that doesn't heat:
  - Acetic acid
- In any case, you want to minimize ethanol & CO$_2$
Homofermentative Inoculants - Expectations

- High lactic acid content, low other products
- Low pH
- Improved DM recovery
- Slightly better animal performance
Homofermentative Inoculants - Results

pH

- Lower but not all the time
- Works more often in hay crop than whole-grain silages

% Trials with lower pH

(Muck and Kung, 1997)
Aerobic Stability Problems

- Is the problem a management problem that can be solved without an additive?
  - 55% to 70% moisture, stability problems are almost always related to management issues
  - Below 55% moisture, you have a number of options:
    - Feed out in winter
    - Homofermentative inoculants for sporadic warm weather issues should make small improvements in stability
    - *L. buchneri* or combination of products for more consistent warm weather issues.
Issues with *L. buchneri*

- Slower growth than *L. plantarum*, takes 45 to 60 days storage time before having much effect.
- Will not reduce heating with immature silage; propionic acid is the best solution.
- Results in dry matter loss.
L buchneri inoculants - Expectations

- Higher acetic acid content
- Better bunk stability
- Slightly elevated pH
- Improved DM recovery from less spoilage offsetting more fermentation losses
- Animal performance - ??
  - Keeping silage cool benefits intake
  - High acetic acid may reduce intake?
Rapidly Fill and Cover

- Fill bunker silos in 1 or, possibly 2 days
- Wrap bales within 3 to 4 hours
Pack Silage Well
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage Pile Height to Top of Slope (feet)</td>
<td>10</td>
<td>August 23, 2007</td>
</tr>
<tr>
<td>Horizontal Portion of Side Slope (ie 3 for 3:1)</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Top Width (feet) [ can be zero]=</td>
<td>100</td>
<td>Values in yellow cells are user changeable</td>
</tr>
<tr>
<td>Silage Delivery Rate to Pile (T AF/Hr)</td>
<td>120</td>
<td>Typical values 15-200 T AF/hr</td>
</tr>
<tr>
<td>Silage Dry Matter Content (decimal ie 0.35)</td>
<td>0.34</td>
<td>Recommended range of DM content = 0.3-0.4</td>
</tr>
<tr>
<td>Silage Packing Layer Thickness (inches)</td>
<td>6</td>
<td>Recommended value is 6 inches or less</td>
</tr>
<tr>
<td>Packing Tractor - Each Tractor Tractor Weight (lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tractor # 1 Typical tractor weight is 10,000-60,000 lbs</td>
<td>40,000</td>
<td>100</td>
</tr>
<tr>
<td>Tractor # 2 Typical tractor weight is 10,000-60,000 lbs</td>
<td>40,000</td>
<td>100</td>
</tr>
<tr>
<td>Tractor # 3 Typical tractor weight is 10,000-60,000 lbs</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tractor # 4 Typical tractor weight is 10,000-60,000 lbs</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Proportioned Total Tractor Weight (lbs)</td>
<td>80,000</td>
<td></td>
</tr>
<tr>
<td>Average Silage Height (feet)</td>
<td>8.1</td>
<td>Green cells are intermediate calculated values</td>
</tr>
<tr>
<td>Packing Factor</td>
<td>501.8</td>
<td>Values in pink cells are results of calculations</td>
</tr>
<tr>
<td>Est. Average Wet Density = Bulk Density (lbs AF/cu ft)</td>
<td>44.5</td>
<td>Wet Density greater than 44 lbs AF/cu ft is recommended</td>
</tr>
<tr>
<td>Maximum Achievable Bulk Density (lbs AF/cu ft)=</td>
<td>73.0</td>
<td>Wet Density greater than Max. Wet Density is unrealistic</td>
</tr>
<tr>
<td>Gas Filled Porosity</td>
<td>0.39</td>
<td>Gas Filled Porosity less than 0.40 is recommended</td>
</tr>
<tr>
<td>Est. Average Dry Matter Density (lbs DM/cu ft)</td>
<td>15.1</td>
<td>Density greater than 15 lbs DM/cu ft is recommended</td>
</tr>
<tr>
<td>Maximum Achievable DM Density (lbs DM/cu ft)=</td>
<td>24.8</td>
<td>DM Density greater than Max. Achievable is unrealistic</td>
</tr>
</tbody>
</table>
Cover bunker or pile