Baleage: Another Option for Managing, Storing and Feeding Your Forage

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Round-Bale Silage – Management Issues to Consider

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Fermentation Characteristics of Round-Bale Silages

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Increasing Use of Wrapped Round Bales

% Dairy Farms That Bale Hay

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>17.9</td>
</tr>
<tr>
<td>2002</td>
<td>18</td>
</tr>
<tr>
<td>2004</td>
<td>23</td>
</tr>
</tbody>
</table>

Hoard’s Dairyman, 2005
Reasons for Increase

- Harvest flexibility
- Feed inventory
- Sell hay crop silage
Goal: Silage Preservation

• **Anaerobic (without air) bacteria convert sugars to lactic acid.**

• **This process lowers the pH and preserves the forage as silage.**
1. Regardless of silo type, most management principles are the same.

- start with high-quality forage
• manage moisture content

• excessively wet or dry silages can both be problematic

• standards vary somewhat with silo type
• eliminate air
• maintain silo integrity

particularly important for plastic structures
- Avoid poor feedout management

Too much exposure to air is problematic
2. Round Bale Silage – Some Considerations
Harvest Factors (Rd-Bale vs. Precision-Chopped)

- lack of chopping action forces sugars to diffuse from inside the plant to reach lactic acid bacteria located on the outside of the forage

- RBS may be less dense (DM/ft3) than some other (chopped) silo types, which also may restrict availability of sugars to lactic acid bacteria
Bale vs. Bag in Alfalfa/Grass Silage

Nicholson et al., 1991

Days of Fermentation

pH

Bale
Bag

Nicholson et al., 1991
Chop Length

- Long forage affecting fermentation?
- Cutting systems available now
  - 1.5 to 6 in. lengths
Alfalfa Bale Silage - 3.7 in Chop

Borreani et al., 2006
Effects of Chop Length

• **Fermentation:**
  – Small positive effect
  – More in sugar-limited and/or dry silages

• **DM Recovery:**
  – 0.5 to 4.0% unit improvement
  – Avg. of 6 trials: 1.4%
Harvest Factors
(Rd-Bale vs. Precision-Chopped)

- Lack of chopping action forces sugars to diffuse from inside the plant to reach lactic acid bacteria located on the outside of the forage.

- RBS may be less dense (DM/ft³) than some other (chopped) silo types, which also may restrict availability of sugars to lactic acid bacteria.

- Lower bale density, and greater ratio of surface area to bale volume, potentially make RBS more susceptible to entrapment and/or penetration by O₂.

- Recommendations for moisture content of RBS are 5 to 20 percentage units lower than for chopped forages; this alone will restrict fermentation.
Harvest Factors
Fermentation Characteristics - Haylage vs. RBS

McCormick et al. (1998)

- annual ryegrass (1993-94)
- 4 x 4 bales
- silages harvested mid-April in southern Louisiana
Harvest Factors (Rd-Bale vs. Hay)

- well-made RBS will often exhibit better quality characteristics than corresponding hays
  - harvest delays (inclement weather)
  - rain damage
  - spontaneous heating
  - weathering after baling (outdoor storage)
Harvest Factors
Annual Ryegrass – Delaying Haying for Favorable Weather

McCormick et al. (1998): annual ryegrass (1993-94); silages harvested mid-April, hay in early May
Hancock and Collins (2006): *alfalfa harvested at mid-bud stage of maturity; hay baled at 19.8% moisture and stored outside, uncovered; hay received two rainfall events totaling 0.6 inches prior to baling.*
Hancock and Collins (2006): alfalfa harvested at mid-bud stage of maturity; hay baled at 19.8% moisture and stored outside, uncovered; hay received two rainfall events totaling 0.6 inches prior to baling.
Spontaneous Heating of Alfalfa/Orchardgrass Hays In Large-Round Bales (Journal Dairy Science 92:2853-2874)

MAX = 72.9°C
MAX = 48.0°C
MAX = 43.0°C

Graphs summarize changes (Final - Initial) for 32 treatments from three trials during 2006-07

ADICP, % of DM

\[ y = 0.0026x^2 - 0.21x + 4.2097 \]
\[ R^2 = 0.961 \]

In Vitro True Digestibility

\[ y = -0.23x + 9.5 \]
\[ r^2 = 0.866 \]
Crop Factors

- **harvest high-quality forages** – expensive equipment generally will not improve forage quality
- **damaged, or mismanaged forages** that ferment poorly in conventional silo types also are likely to make poor RBS
- **harvest at proper growth stage (sugar status)**
- **remember that forage species are inherently different**
  - legumes ≠ cool-season (cs) grasses
  - cs grasses ≠ warm-season (ws) grasses
  - ws annuals ≠ ws perennials
Crop Factors
Sugar Status - Nonstructural CHO in Stem Bases of Perennial Cool-Season Grasses

CHO, %

Time

green up

stem elongation

anthesis

mature seed
Crop Factors
Species Differences - Fermentation Characteristics

Han et al. (2006): mean of ideal (48.8%) and low (29.5%) moisture RBS
Crop Factors
Species Differences – Effects on pH

Han et al. (2006): mean of ideal (48.8%) and low (29.5%) moisture RBS
Moisture Management

- Generally, RBS should be packaged at 40 to 60% moisture; the average for the whole field or group of bales should be about 50%.
- Bale weight can be a safety/equipment issue.
- Systems for RBS will generally accommodate excessively dry forages better than excessively wet ones.
  - clostridial fermentations (wet)
  - bale deformation, tensile stress on plastic (wet)
  - migration/concentration of water
  - integrity of plastic (dry)
- moisture in the plant ≠ moisture on the plant
Moisture Management
Alfalfa – Effects of Rain-Damage on Fermentation

Borreani and Tabacco (2006)
Moisture Management

Alfalfa – Effects of Moisture Content on Bale Deformation (ft vertical/ft horizontal)

Hancock and Collins (2006): combined data from two trials; alfalfa harvested at midbud stage of maturity; estimate for hay is mean of bales made at 16.6 and 19.8% moisture, and stored outdoors, uncovered.
Elimination of Air

Why?

- respiration of plant sugars to CO$_2$, water, and heat
- dry matter loss
- reduces pool of fermentable CHO (sugars)
- increases (indirectly) fiber content of the silage
- decreases energy density of silage
- heat damage to silage proteins
● reduce ground speed
● increase PTO speed
● thinner windrows will increase revolutions/bale
● manage moisture appropriately (≈ 50%)
● maintain constant bale size
● baler/operator experience

elimination of air

bulk density >10 lbs DM/ft³
## Elimination of Air

**Alfalfa - Effects of Bale Density on Fermentation**

<table>
<thead>
<tr>
<th>Moisture</th>
<th>58.7%</th>
<th>52.4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, lbs/ft³</td>
<td>12.9</td>
<td>10.9</td>
</tr>
<tr>
<td>pH</td>
<td>4.7</td>
<td>4.9</td>
</tr>
<tr>
<td>lactic acid, %</td>
<td>7.0</td>
<td>6.5</td>
</tr>
<tr>
<td>acetic acid, %</td>
<td>2.4</td>
<td>3.8</td>
</tr>
<tr>
<td>max temp, °F</td>
<td>107</td>
<td>109</td>
</tr>
<tr>
<td>DM REC, %</td>
<td>98.6</td>
<td>98.6</td>
</tr>
</tbody>
</table>

Han et al. (2004): high density bales created at 842 x 10³ Pa of chamber pressure; lower density bales made at 421 x 10³ Pa.
### Elimination of Air

**Alfalfa - Effects of Precutting System on Bale Density**

<table>
<thead>
<tr>
<th>Trial</th>
<th>Moisture</th>
<th>Rain</th>
<th>Normal</th>
<th>Chopped</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>%</td>
<td>inches</td>
<td>-------- lbs/ft³</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>62.7</td>
<td>0</td>
<td>11.4</td>
<td>11.9</td>
</tr>
<tr>
<td>2</td>
<td>50.6</td>
<td>0</td>
<td>12.3</td>
<td>12.8</td>
</tr>
<tr>
<td>3</td>
<td>39.2</td>
<td>1.4</td>
<td>10.7</td>
<td>11.2</td>
</tr>
<tr>
<td>3</td>
<td>62.3</td>
<td>0</td>
<td>10.2</td>
<td>10.4</td>
</tr>
</tbody>
</table>

Borreani and Tabacco (2006): 4 x 4-ft bales were chopped with a cutting system consisting of 15 knives spaced 93 mm apart.
Elimination of Air
Sealing the Bale

- lack of uniformity will create air pockets for in-line wrapped bales
- use UV-resistant plastic
- wrap as quickly as possible after baling (within 2 hours is ideal)
- use (at least) four layers of stretched plastic (six for long-term storage and/or in southern states)
- storage site selection/maintenance is important
- do not puncture plastic - isolate from cattle, pets, and vermin
- patch holes with appropriate tape
Hydraulic Bale Grapple
## Elimination of Air

**Alfalfa - Effects of Delaying Wrapping on Internal Bale Temperature (63% Moisture)**

<table>
<thead>
<tr>
<th>Delay</th>
<th>Wrap</th>
<th>At Wrapping</th>
<th>Day 1*</th>
<th>Day 2</th>
<th>Day 4</th>
<th>Day 6</th>
<th>Day 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td></td>
<td>°F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No wrap</td>
<td></td>
<td>99</td>
<td>121</td>
<td>127</td>
<td>150</td>
<td>145</td>
<td>135</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>91</td>
<td>93</td>
<td>95</td>
<td>89</td>
<td>84</td>
<td>76</td>
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<tr>
<td>24</td>
<td></td>
<td>110</td>
<td>119</td>
<td>114</td>
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<td>92</td>
<td>75</td>
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<tr>
<td>48</td>
<td></td>
<td>136</td>
<td>142</td>
<td>130</td>
<td>109</td>
<td>95</td>
<td>72</td>
</tr>
<tr>
<td>96</td>
<td></td>
<td>147</td>
<td>145</td>
<td>133</td>
<td>110</td>
<td>92</td>
<td>73</td>
</tr>
</tbody>
</table>

Vough et al. (2006): data adapted from Undersander et al. (2003); all square bales wrapped with eight mils of plastic film.

* Denotes days from wrapping.
pH In Alfalfa Bale Silage

Hancock and Collins, 2006
NDF In Alfalfa Bale Silage

Hancock and Collins, 2006
Summary

• Producers can make good silage using baling and wrapping techniques.

• Most principles of management for conventional chopped silage still apply to RBS.

• Moisture management is critical; RBS techniques will accommodate drier (<50%) forages much better than relatively wet (>65%) ones.
Summary

• Recommendation: start baling about 5+ percentage units drier than for making silage in other silo types to avoid a clostridial silage.
Summary

- Can get a good fermentation over a range of moisture contents.
- But fermentation is somewhat restricted (occurs at slower rate) compared to other silo types.
- Differences appear due to a combination of density, chop length, layers of plastic.
Any questions?