Management of Baled Silages – Things to Consider

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Why Choose Baled Silage over Hay?
- Well-made baled silage will often exhibit better quality characteristics than corresponding hays
  - Less leaf loss (legumes)
  - Less wilting time required
  - Reduced risk/exposure to rain damage
  - Little or no spontaneous heating
  - No weathering after baling (outdoor storage)

Regardless of silo type, most management principles are the same.
- Start with high-quality forage

Goal: Silage Preservation

Lactic Acid, The “Good Silage” Acid

Homofermentative
plant sugars → lactic acid

Heterofermentative (multiple pathways)
glucose or fructose + ADP + Pi → lactate, acetate, ethanol, mannitol, ATP, H₂O, and CO₂

Adapted from Hancock and Collins (2006)
Typical Characteristics of Chopped Grass Silages in Northern Europe from Different Fermentation Types

<table>
<thead>
<tr>
<th>Item</th>
<th>Moisture, %</th>
<th>pH</th>
<th>Ammonia N, % of N</th>
<th>Lactic Acid, %</th>
<th>Acetic Acid, %</th>
<th>Butyric Acid, %</th>
<th>WSC, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilted</td>
<td>81.0</td>
<td>3.9</td>
<td>7.8</td>
<td>10.2</td>
<td>3.6</td>
<td>0.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Clostridial</td>
<td>69.2</td>
<td>4.2</td>
<td>8.3</td>
<td>5.9</td>
<td>2.4</td>
<td>0.1</td>
<td>4.8</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>83.0</td>
<td>6.2</td>
<td>24.6</td>
<td>0.1</td>
<td>2.4</td>
<td>3.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Sterilized</td>
<td>82.4</td>
<td>4.8</td>
<td>12.8</td>
<td>3.4</td>
<td>9.7</td>
<td>0.2</td>
<td>0.1</td>
</tr>
</tbody>
</table>

adapted from McDonald and Edwards (1976)

Baled Silage vs. Precision-Chopped Haylage

- Silage fermentation is restricted by the lower moisture content of baled silage
- Lack of chopping action in baled silages forces sugars to diffuse from inside the plant to reach lactic-acid producing bacteria adhered to the outside of the forage
- Although dependent on many factors, baled silage may be less dense (DM/ft³) than some other (chopped) silo types, which also may restrict availability of sugars to lactic-acid producing bacteria

Fermentation Characteristics of Alfalfa Forages Ensiled as Large-Round Bales or as Precision-Chopped Silages

1 Mean moisture concentration = 61%.
Nicholson et al. (1991)

Baled vs. Precision-Chopped Silage Alfalfa/Grass

Muck (2006) – adapted from Nicholson et al. (1991); moisture concentration was 61%

Bale-Cutting Effects: Long-Stem vs. Cut Baled Alfalfa/Grass Silages

Coblentz and Akins (2019)

Plant Factors

- Water Soluble Carbohydrates (WSC)
- Buffering Capacity
Sources of Variation for WSC

- Species
- Cultivar Within Species
- Stage of Growth
- Time of Day
- Climate
- Drought
- Frost Events
- N Fertilization
- Rain
- Poor/Extended Wilting Conditions
- Management

Water Soluble Carbohydrates (WSC) for Selected Forage Crops

<table>
<thead>
<tr>
<th>Crop/Species</th>
<th>WSC, % of DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Silage</td>
<td>10 - 20</td>
</tr>
<tr>
<td>Forage Sorghum</td>
<td>10 - 20</td>
</tr>
<tr>
<td>Sudan, Sorghum-Sudan, Millet</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Rye, Oat, Wheat, Triticale</td>
<td>8 - 12</td>
</tr>
<tr>
<td>Ryegrass</td>
<td>8 - 12</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>4 - 7</td>
</tr>
<tr>
<td>Bermudagrass, Stargrass</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Bahiagrass</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Limopogras</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Perennial Peanut</td>
<td>1 - 4</td>
</tr>
</tbody>
</table>

Adesogan and Newman, 2013

Water Soluble Carbohydrates (WSC) for Fall-Grown Oat as Affected by N Fertilization Rate

<table>
<thead>
<tr>
<th>N Fertilization Rate lbs N/acre</th>
<th>2011 % of DM</th>
<th>2012 % of DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12.4, 19.3</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>12.3, 17.4</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>11.5, 17.4</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>10.0, 16.5</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>10.1, 16.3</td>
<td></td>
</tr>
<tr>
<td>SEM</td>
<td>0.76, 0.53</td>
<td></td>
</tr>
</tbody>
</table>

Contrast

- Linear: 0.004 < 0.001
- Quadratic: ns ns
- Cubic: ns ns

Coblentz et al. (2014)

WSC and Starch in Rain-Damaged Alfalfa (1.9 inches)

Caution: Tests for ergovaline were reduced in response to ensiling, but total ergot alkaloids were not.

Roberts et al. (2014)
Moisture Management

Generally, baled silage should be packaged at 45 to 55% moisture (Shinners, 2003); the average for the whole field or group of bales should be about 50%.

- moisture recommendations for chopped silages are < 70%
- production of silage fermentation acids is positively associated with moisture concentration
- as a result, baled silage fermentation is inherently restricted, resulting in a slower fermentation, and a greater (less-acidic) final pH

Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales at High (60 to 65%) or Ideal (49 to 54%) Moisture

Lactic Acid

Total Acids

Days of Fermentation

Nicholson et al. (1991)

Fermentation Characteristics of Alfalfa Forages Ensiled in Large-Round Bales at High (60 to 65%) or Ideal (49 to 54%) Moisture

Nicholson et al. (1991)

Long-Stem vs. Cut Baled Alfalfa/Grass Silages (Again)

Coblentz and Akins, unpublished

Lactic Acid Production in Alfalfa Silages Packaged in Large-Rectangular Bales

Coblentz et al. (2014)

No Why Not Bale Forage Wetter?

- Safety
- Equipment/Baler
- Clostridial Fermentations

1 Red and blue dots represent different harvests.
**Clostridial Fermentations**

*Clostridial spores*

Sugar, Lactic Acid, and Protein

Butyric Acid, Ammonia

"Bad, Evil-Smelling Silage"

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**Clostridial Fermentations**

(Products: Butyric Acid, Ammonia)

Some Characteristics of High-Risk Forages

- high moisture concentration
- direct cut forages
- immature, rapidly growing forages
- highly contaminated with dirt, manure, or both
  - low sugar
  - high buffering capacity
  - high protein
  - leguminous
- non-homogenous forages (baled silage)

The best prevention is to wilt the forage prior to ensiling! As such, baled silage is generally at low risk.

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**Clostridial Counts (log_{10} genomic copies/g) for Pre-Ensiled and Post-Ensiled Alfalfa Forages Following Applications of Dairy Slurry Using qPCR Methods**

<table>
<thead>
<tr>
<th>Slurry Application Treatment</th>
<th>No Slurry</th>
<th>Slurry</th>
<th>1 Week</th>
<th>2 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-ensiled</td>
<td>4.5</td>
<td>6.5</td>
<td>6.6</td>
<td>6.6</td>
</tr>
<tr>
<td>Post-ensiled</td>
<td>4.5</td>
<td>6.5</td>
<td>6.6</td>
<td>6.6</td>
</tr>
</tbody>
</table>

**Butyric Acid in Alfalfa Round Bale Silage**

\[ Y = 0.0014 x^2 - 0.058 x + 1.7 \]

\[ R^2 = 0.821 \]

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**Butyric Acid in Alfalfa Round Bale Silage and Voluntary Intake by Gestating Sheep**

Adapted from Cobleitz et al. (2016) and Niyigena et al. (2019)

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**Weather Factors**

Temperature
Effects of Cold Weather on Fermentation of Fall-Grown Oat

Coblentz et al. (2015)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Bale Moisture</th>
<th>WSC</th>
<th>Lactic Acid</th>
<th>Ethanol</th>
<th>pH</th>
<th>NDF</th>
<th>CP</th>
<th>TDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boot Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>67.6</td>
<td>22.6</td>
<td>...</td>
<td>...</td>
<td>6.90</td>
<td>40.3</td>
<td>13.7</td>
<td>71.4</td>
</tr>
<tr>
<td>Final</td>
<td>74.0</td>
<td>17.8</td>
<td>4.82</td>
<td>5.82</td>
<td>4.61</td>
<td>47.0</td>
<td>17.9</td>
<td>67.8</td>
</tr>
<tr>
<td>Early Heading Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>63.7</td>
<td>21.0</td>
<td>...</td>
<td>...</td>
<td>6.94</td>
<td>46.9</td>
<td>14.6</td>
<td>69.7</td>
</tr>
<tr>
<td>Final</td>
<td>67.3</td>
<td>11.9</td>
<td>1.63</td>
<td>4.85</td>
<td>5.71</td>
<td>55.0</td>
<td>16.0</td>
<td>60.0</td>
</tr>
</tbody>
</table>

1/ 'Vista' fall-grown oat.

Elimination of Air

• respiration of plant sugars to CO₂, water, and heat
• reduces pool of fermentable sugars
• dry matter loss
• increases (indirectly) fiber content of the silage
• decreases energy density of silage

Consequences of Air Access!
(Mostly Before Sealing)

● reduce ground speed
● thinner windrows will increase revolutions/bale
● manage moisture appropriately (> 50%)
● maintain constant bale size
● operator/baler experience

Source: R. E. Pitt

Sealing the Bale

• wrap as quickly as possible after baling (within 2 hours is ideal; minimal damage likely within 24 hours)
• use (at least) four layers (1 mil or 25 microns) of stretched plastic (at least 6 or 8 for long-term storage and/or in southern states)
• storage site selection/maintenance is important
• patch holes with appropriate tape
• do not puncture plastic - isolate from cattle, pets, and vermin
Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales as Affected by Wrapping Delays

Coblentz et al. (2016)

How Many Plastic Layers?

<table>
<thead>
<tr>
<th>Plastic Layers</th>
<th>Bale Moisture</th>
<th>pH</th>
<th>Lactic Acid</th>
<th>Acetic Acid</th>
<th>Mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>59.4</td>
<td>5.44</td>
<td>2.81</td>
<td>3.53</td>
<td>7.7</td>
</tr>
<tr>
<td>4</td>
<td>65.9</td>
<td>4.76</td>
<td>4.52</td>
<td>2.81</td>
<td>2.7</td>
</tr>
<tr>
<td>6</td>
<td>65.0</td>
<td>4.79</td>
<td>4.83</td>
<td>2.21</td>
<td>0</td>
</tr>
</tbody>
</table>

* Summary of 3 trials with alfalfa silages stored for 150 days.

Effects of Wrapping Layers and an Oxygen-Limiting Barrier on the 30-mm Surface Layer of Alfalfa Baled Silage

Borreani and Tabacco (2008)

* Four plastic layers may be adequate for fermentation, but may not provide adequate security from birds, vermin, or internal puncture by rigid stems.

** Differences between OB and non-OB plastics often have been limited to more desirable counts of yeasts and molds at the surface layer, rather than improved fermentation or nutritive value measured on a whole-bale basis.

Effects of Simulated Bird Damage to Grass Baled Silages in Ireland

McNamara et al. (2002)

Bales were intentionally punctured with 0, 1, 10, or 50 small (3-mm) holes, or 1 large (24-mm) hole to simulate bird damage, and then stored for 155 days.
Feedout Management

Aerobic Stability of Wheat and Orchardgrass Baled Silage During Winter
Rhein et al. (2005)

Wheat
- harvested at milk stage
- 37.6% moisture
- 11.1 lbs DM/ft

Orchardgrass
- harvested at heading stage
- 45.6% moisture
- 13.6 lbs DM/ft

Summary

• Forage crops differ; learn their characteristics.
• Most principles of management for conventional chopped silage still apply to baled silage.
• Moisture management is critical; generally, baled silage techniques will accommodate drier (<50%) forages better than relatively wet (>60%) ones.
• Fermentation occurs at a slower rate for baled silage because forages are:
  - ensiled on a whole-plant basis
  - usually drier and less dense than chopped silages

Summary

• As a result, producers should diligently address other management details:
  - maximize bale density (> 10 lbs DM/ft)
  - consider an inoculant (LAB) if forage is damaged, manure has been applied, or if bale moisture approaches 60% (alfalas); grasses are a bit more forgiving
  - apply plastic wrap promptly and properly (damage is likely relatively minor up to 24 hours)
  - protect the product (4 plastic layers is the minimum, 6 or 8 are better)
  - stabilize your investment by excluding air (select a good storage site, check and repair holes)

Q U E S T I O N S?

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