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## 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)

### Why Choose Baled Silage over Hay?

**Alfalfa Forages**

Condition	Forage Type	Pre-Storage NDF (%)	Post-Storage NDF (%)
No Rain	Trial 1 Silage	~38	~39
	Trial 1 Hay	~38	~46
Rain	Trial 2 Silage	~36	~34
	Trial 2 Hay	~46	~49

adapted from Hancock and Collins (2006)

### Regardless of silo type, most management principles are the same.

- start with high-quality forage

### Goal: Silage Preservation

Source: R. E. Pitt

**Ideally, the goal is to establish a stable silage mass by lowering pH and maintaining anaerobic conditions!**

### Lactic Acid, The "Good Silage" Acid

plant sugars → lactic acid

**Homofermentative**  
glucose or fructose + 2ADP + 2 Pi → 2 **lactate** + 2 ATP + 2 H<sub>2</sub>O

**Heterofermentative (multiple pathways)**  
glucose or fructose + ADP + Pi → **lactate**, acetate, ethanol, mannitol, ATP, H<sub>2</sub>O, and CO<sub>2</sub>

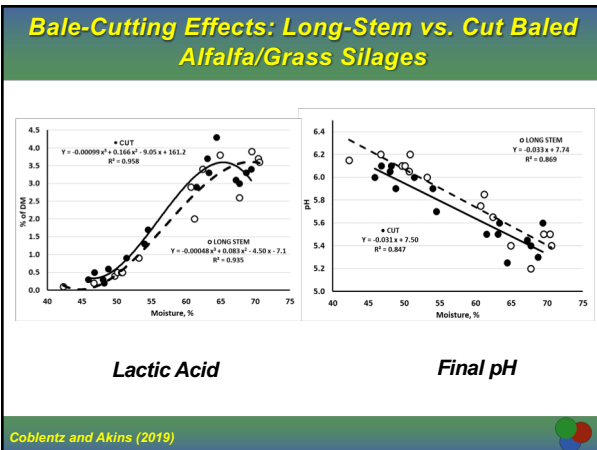
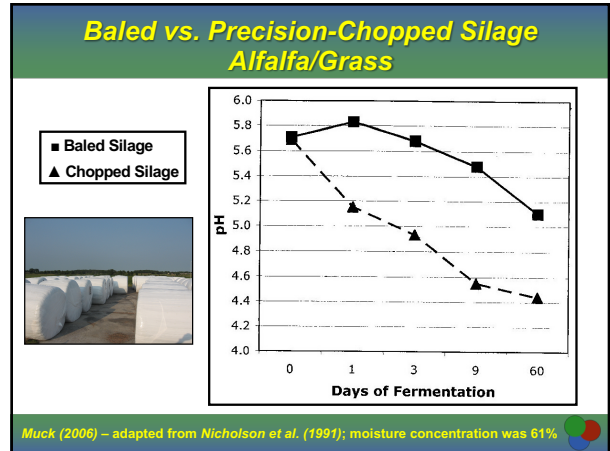
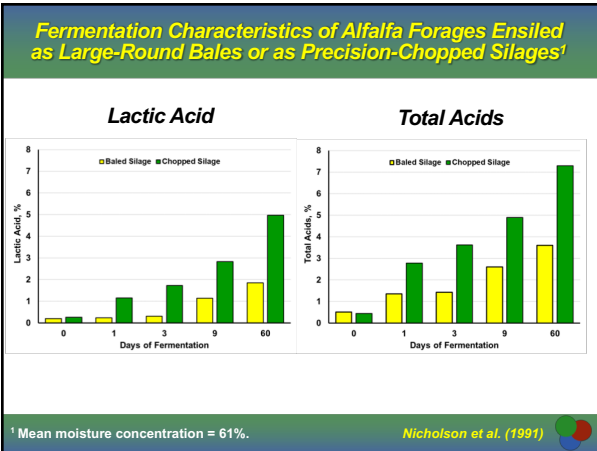
### Typical Characteristics of Chopped Grass Silages in Northern Europe from Different Fermentation Types

Item	Lactic Acid	Wilted	Clostridial	Acetic Acid	Sterilized
Moisture, %	81.0	69.2	83.0	82.4	78.8
pH	3.9	4.2	5.2	4.8	5.1
Ammonia N, % of N	7.8	8.3	24.6	12.8	3.0
Lactic Acid, %	10.2	5.9	0.1	3.4	2.6
Acetic Acid, %	3.6	2.4	2.4	9.7	1.0
Butyric Acid, %	0.1	0.1	3.5	0.2	0.1
WSC, %	1.0	4.8	0.6	0.3	13.3

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/ft<sup>3</sup>) than some other (chopped) silo types, which also may restrict availability of sugars to lactic-acid producing bacteria




### Plant Factors

- Water Soluble Carbohydrates (WSC)
- Buffering Capacity

### Fermentable Sugars Water-Soluble Carbohydrates (WSC)

**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



Lactic Acid,  
The "Good Silage" Acid  
plant sugars → lactic acid

### Water Soluble Carbohydrates (WSC) for Selected Forage Crops

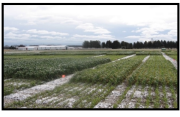
Crop/Species	WSC, % of DM
Corn Silage	10 - 20
Forage Sorghum	10 - 20
Sudan, Sorghum-Sudan, Millet	10 - 15
Rye, Oat, Wheat, Triticale	8 - 12
Ryegrass	8 - 12
Alfalfa	4 - 7
Bermudagrass, Stargrass	2 - 4
Bahiagrass	< 5
Limpograss	< 5
Perennial Peanut	1 - 4

Adesogan and Newman, 2013

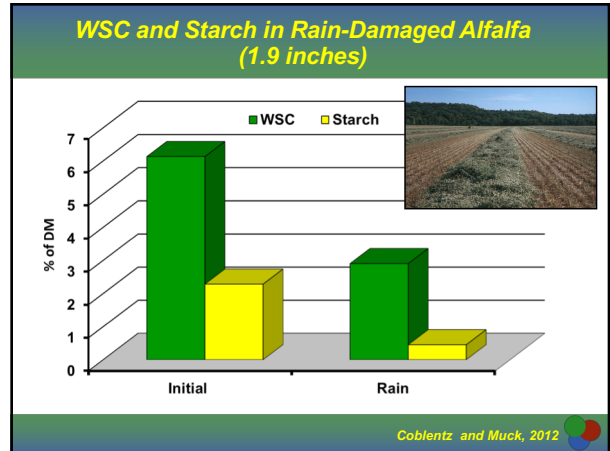
### Water Soluble Carbohydrates (WSC) for Fall-Grown Oat as Affected by N Fertilization Rate

N Fertilization Rate	2011	2012
lbs N/acre		% of DM
0	12.4	19.3
22	12.3	17.4
45	11.5	17.4
67	10.0	16.5
90	10.1	16.3
SEM	0.76	0.53
<b>Contrast</b>	<b>P &gt; F</b>	
Linear	0.004	< 0.001
Quadratic	ns	ns
Cubic	ns	ns

1 ns, non-significant (P > 0.05)



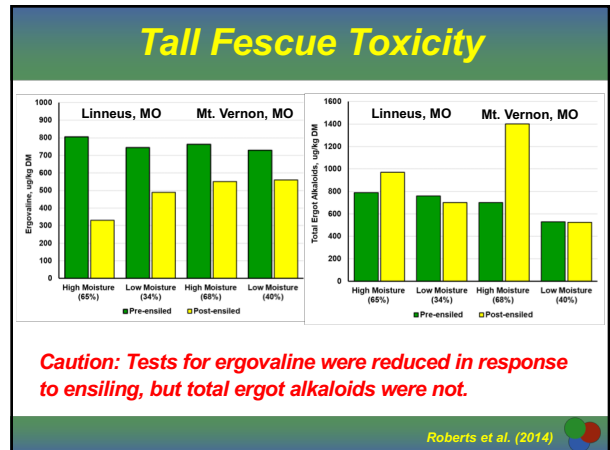
Coblentz et al. (2014)



### Buffering Capacities (mEq/kg DM) for Selected Forage Crops

Crop/Species	Range	Mean
Corn Silage	149-225	185
Timothy	188-342	265
Fall Oat (Headed)	300-349	323
Orchardgrass	247-424	335
Red Clover	...	350
Fall Oat (Boot)	360-371	366
Italian Ryegrass	265-589	366
Alfalfa (mid-bloom)	313-482	370
Perennial Ryegrass	257-558	380
Alfalfa (1/10 bloom)	367-508	438
Alfalfa	390-570	472
White Clover	...	512

compiled from various sources



### 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

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)

#### Lactic Acid

$Y = -0.00099x^2 + 0.166x - 0.05 + 151.2$   
 $R^2 = 0.958$

#### Final pH

$Y = -0.0033x + 7.24$   
 $R^2 = 0.869$

Coblentz and Akins, unpublished

### Lactic Acid Production in Alfalfa Silages Packaged in Large-Rectangular Bales<sup>1</sup>

<sup>1</sup> Red and blue dots represent different harvests.

Coblentz et al. (2014)

### So Why Not Bale Forage Wetter?

- Safety
- Equipment/Baler
- Clostridial Fermentations\*

### Clostridial Fermentations

**Clostridial spores**

**Sugar, Lactic Acid, and Protein**

**Butyric Acid, Ammonia  
"Bad, Evil-Smelling Silage"**

### 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.**

### Clostridial Counts (log<sub>10</sub> genomic copies/g) for Pre-Ensiled and Post-Ensiled Alfalfa Forages Following Applications of Dairy Slurry Using qPCR Methods<sup>1</sup>

Slurry Application Treatment	Pre-ensiled (log <sub>10</sub> cfu/g)	Post-ensiled (log <sub>10</sub> cfu/g)
No Slurry	~3.8	~4.2
Stubble	~4.5	~5.2
1 Week	~4.6	~5.4
2 Weeks	~4.8	~5.8

<sup>1</sup> Clostridium tyrobutyricum was not detected in dairy slurry or any forage/silage. Coblenz et al. (2014)

### Butyric Acid in Alfalfa Round Bale Silage

$Y = 0.0014 x^2 - 0.098 x + 1.7$   
 $R^2 = 0.651$

Coblenz et al. (2016)

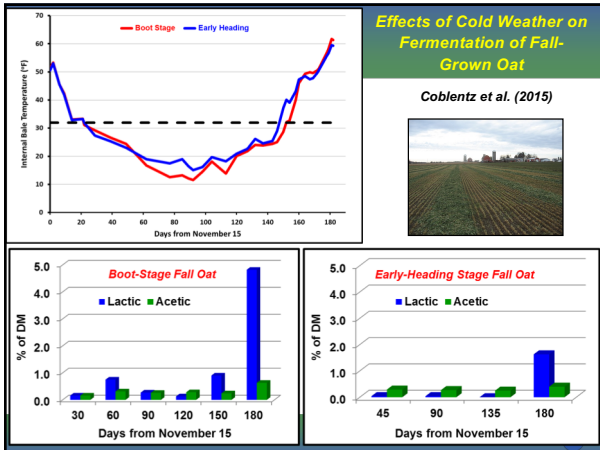
### Butyric Acid in Alfalfa Round Bale Silage and Voluntary Intake by Gestating Sheep

Parameter	Silage 1	Silage 2
Butyric Acid, % of DM	~1.0	~0.7
NH <sub>3</sub> -N, % of N	~16	~14
DM or OMI intake, % BW	~2.2	~2.0

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

### Weather Factors

#### Temperature

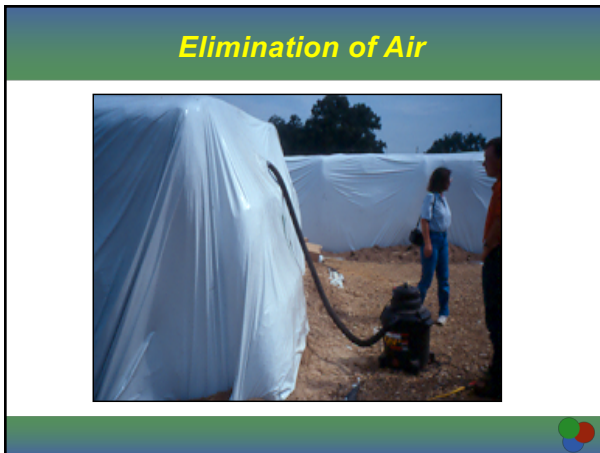


### Ethanol-Dominated Fermentation in Highly Sugared Forage Crops<sup>1</sup>

Treatment	Bale Moisture	WSC	Lactic Acid	Ethanol	pH	NDF	CP	TDN
		----- % of DM -----			----- % of DM -----			
<b>Boot Stage</b>								
Initial	67.6	22.6	...	...	6.90	40.3	13.7	71.4
Final	74.0	17.8	4.82	5.82	4.61	47.0	17.9	67.8
<b>Early Heading Stage</b>								
Initial	63.7	21.0	...	...	6.94	46.9	14.6	69.7
Final	67.3	11.9	1.63	4.85	5.71	55.0	16.0	60.9

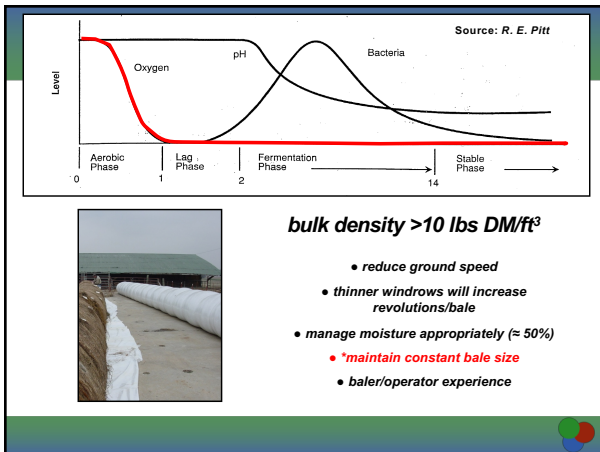
<sup>1</sup> 'Vista' fall-grown oat.

Coblentz et al. (2015)



### Consequences of Air Access! (Mostly Before Sealing)

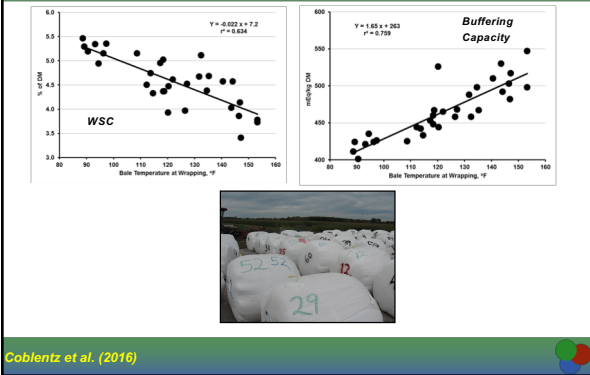
- respiration of plant sugars to CO<sub>2</sub>, water, and heat
- reduces pool of fermentable sugars
- dry matter loss
- increases (indirectly) fiber content of the silage
- decreases energy density of silage



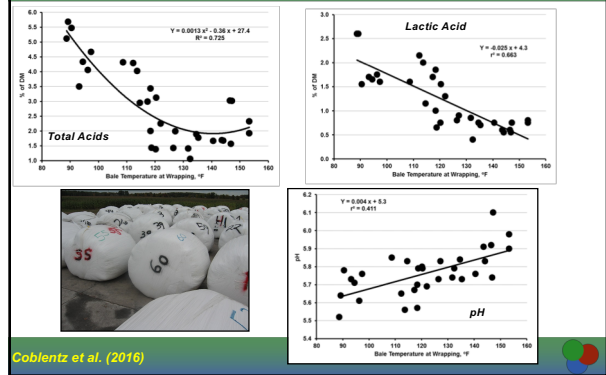
### Sealing the Bale

- 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

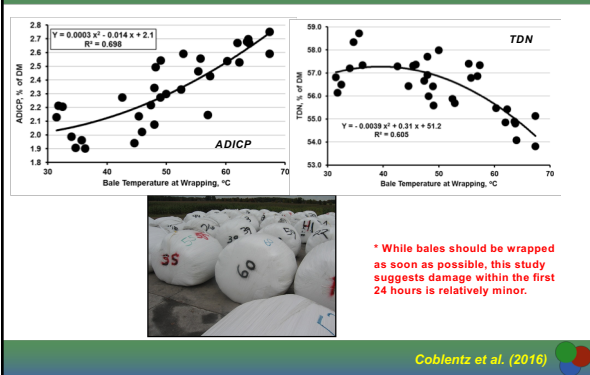
**Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales as Affected by Wrapping Delays**



**Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales as Affected by Wrapping Delays**



**Fermentation Characteristics of Alfalfa Ensiled in Large-Round Bales as Affected by Wrapping Delays**



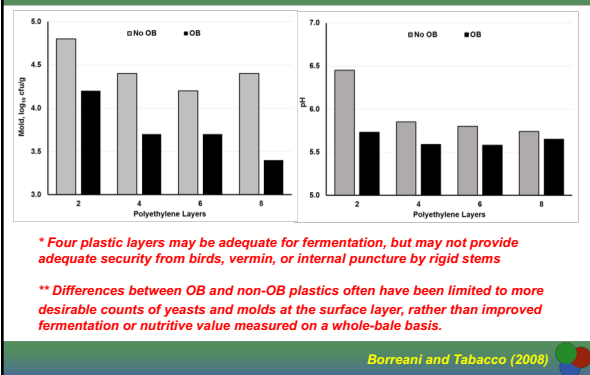
**How Many Plastic Layers?**

Plastic Layers	Bale Moisture	pH	Lactic Acid	Acetic Acid	Mold
#	%		% of DM		
4	59.4	5.44	2.81	3.53	7.7
6	65.9	4.76	4.52	2.81	2.7
8	65.0	4.79	4.83	2.21	0

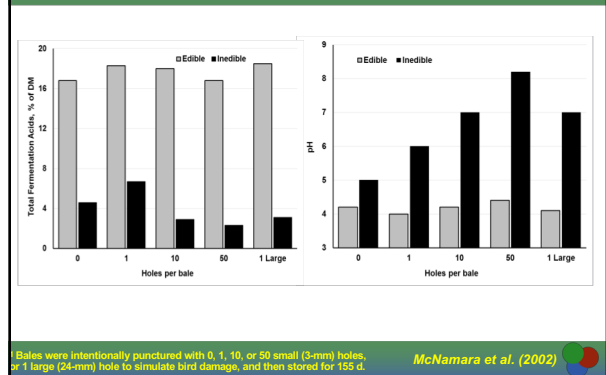
\* Summary of 3 trials with alfalfa silages stored for 150 days.

Keller et al. (1998)


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



**Effects of Simulated Bird Damage to Grass Baled Silages in Ireland<sup>1</sup>**







**Aerobic Stability of Wheat and Orchardgrass Baled Silage During Winter**

Rhein et al. (2005)

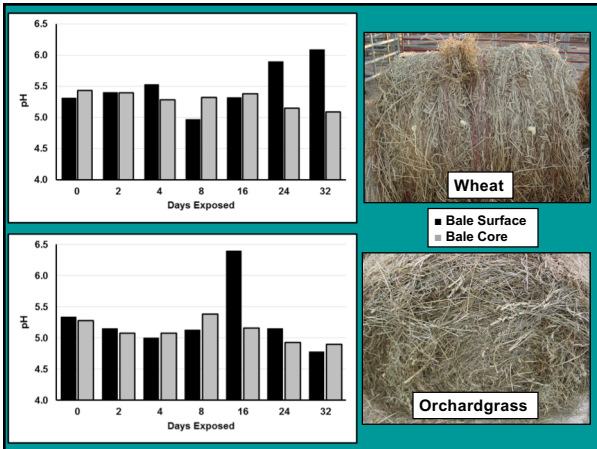
**Wheat**

- harvested at milk stage
- 37.6% moisture
- 11.1 lbs DM/ft<sup>3</sup>

**Orchardgrass**


- harvested at heading stage
- 45.6% moisture
- 13.6 lbs DM/ft<sup>3</sup>





### 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<sup>3</sup>)
  - consider an inoculant (LAB) if forage is damaged, manure has been applied, or if bale moisture approaches 60% (alfalfa); 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)

### QUESTIONS?

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