Chopping & Ensiling

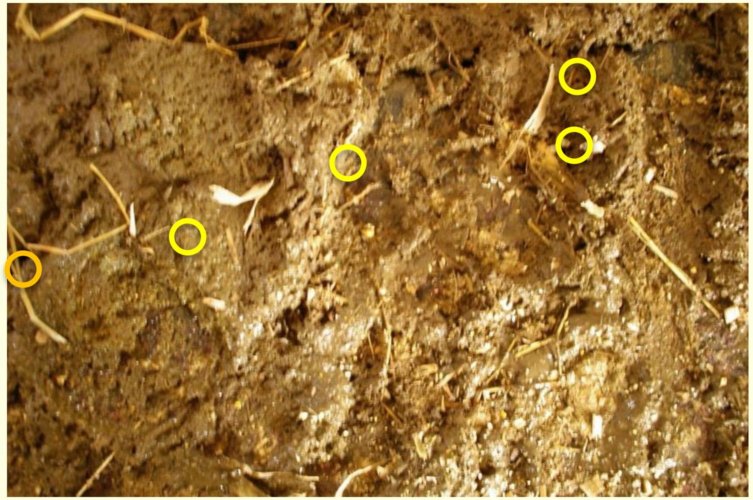
Dr. Dan Undersander
University of Wisconsin

- Forage chop length
- Use of Inoculants
- Packing
- Rate of fill

Chopping length

- Considerations:
  - Adequate physically effective fiber
  - Longer chop length results in poorer packing
  - Shorter chop length requires excessive energy (fuel)

Undigested corn kernels in manure



Chopping length

- Chop at 60 to 65% moisture (30 to 35% Dry matter)
- Cut length 2 to 2.5 cm, with 20% over 4 cm
  - Longer makes compaction more difficult
    - Good compaction - Faster acid fermentation
    - Good compaction - Less spoilage on feedout
  - Improved feed uptake

Adequate crop processing

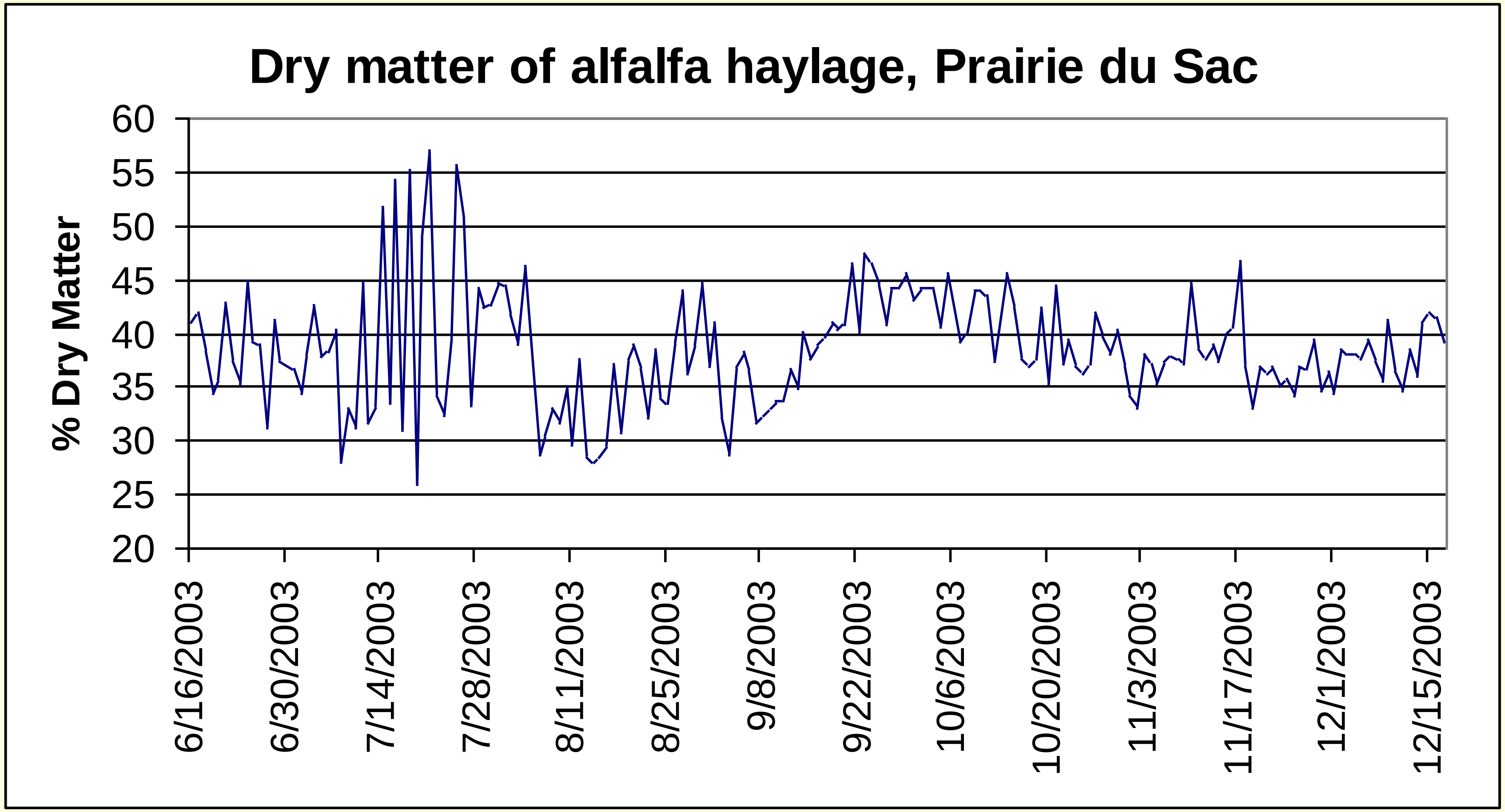
To determine if silage is adequate processed:

Place chopped whole plant corn into pan/bucket of water

Agitate so kernels sink to bottom; remove floating material and drain water so only kernels remain

Adequately processed materials should have no whole kernels (as at right)

Variation in forages



Measuring Silage Dry matter

- Microwave
- Koster Tester
- Hand held NIR units
- NIR from Chopper

Measuring Silage Dry Matter

- Microwave
  - Cut/chop forage into 6 cm lengths or less
  - Microwave for 3 min
  - Remove sample, stir
  - Microwave for 3 min
  - Weigh, the microwave for 1 minute
  - Reweigh, repeat until 0 weight loss

Measuring Silage Dry matter

Air Fryer

- Cut/chop into 6 cm lengths
- Weigh Sample
- Place in Air Fryer until dry (approximately 25 min)
- Weigh

Measuring Silage Dry Matter

- Microwave
- Koster Tester
  - Dry,
  - Weigh
  - Repeat until 0 weight loss

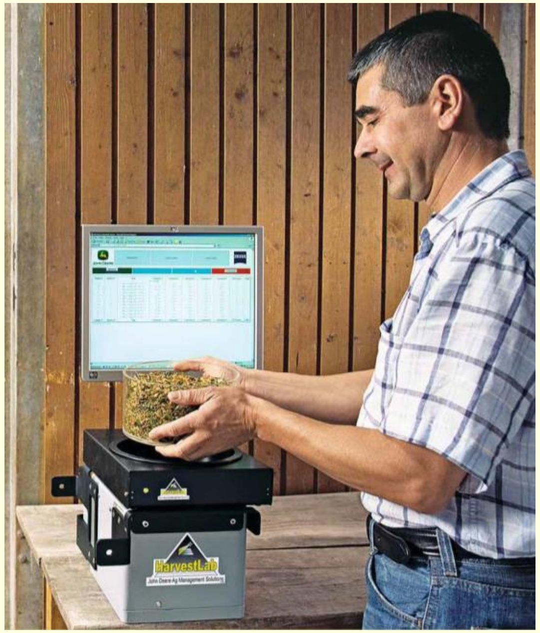
Measuring Hay & Silage Dry matter

Measuring Silage Dry Matter

- Microwave
- Koster Tester
- Hand held NIR unit

Measuring Silage Dry Matter

- Microwave
- Koster Tester
- Handheld NIR units
- NIR from Chopper



Chopping silage

Purpose of Inoculants

- Lactic acid bacteria ferment sugars in the crop and help preserve it.
- Help ensure that the fermentation goes in the direction that you want it.
  - Drop pH rapidly
    - Reduce heating loss
    - To reduce protein solubilization
    - Prevent growth of undesirable microbes

Inoculants

- Bacteria
  - Lactobacillus
  - Buchneri
- Enzymes
  - Cellulase
  - ß-glucanase
- Acid
  - Formic acid
  - Propionic acid

Different Types of Bacterial 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

  1 6-C Sugar $\rightarrow$ 2 Lactic Acid

- Heterofermenter

  1 6-C Sugar $\rightarrow$ 1 Lactic Acid + 1 Acetic Acid + CO_2

  1 6-C Sugar $\rightarrow$ 1 Lactic Acid + 1 Ethanol + CO_2

  1 Lactic Acid $\rightarrow$ 1 Acetic Acid + CO_2 (*L. buchneri*, not all heteros)

Inoculants

- Silage additives whose main ingredients are lactic acid and/or acetic acid producing bacteria

  - Lactic acid bacteria ferment sugars in the crop and help preserve it.
  - Additional bacteria help insure that the fermentation goes in the direction that you want it.

End Product Comparison

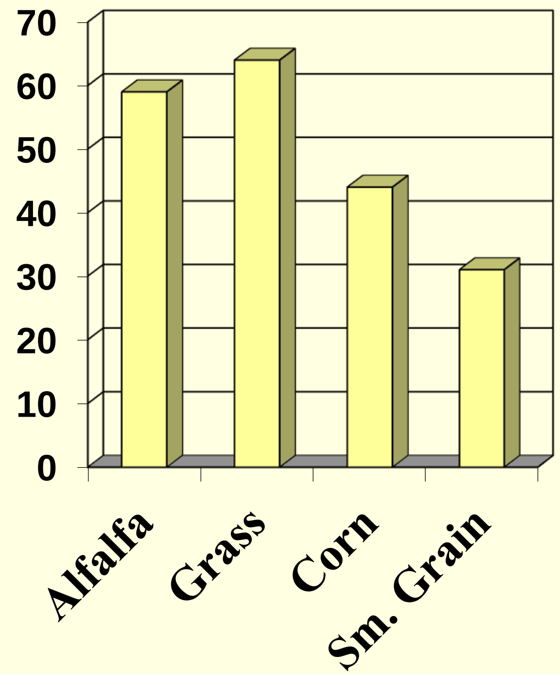
- **Lactic acid** - strong acid; weak spoilage inhibitor; fermented in rumen
- **Acetic acid** - weak acid; good spoilage inhibitor; not fermented in rumen
- **Ethanol** - neutral; poor spoilage inhibitor; partially fermented in rumen
- **Carbon dioxide** - lost dry matter

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?
- Corn Silage:
  - *L. Buchneri* good alternative to propionic acid or anhydrous ammonia
    - Safer to handle
    - Cost competitive
    - Similar effects on DM recovery & animal performance with all three additives
    - If multiple silos/bunkers, use only on the silage to be fed in warm weather

Issues with *L. buchneri*

- Slower growth than *L. plantarum*, takes 45 to 60 days storage time before having much effect
- Not an answer to heating problems with immature silage; propionic acid is the best solution.
- Adding at feeding no benefit.

Inoculant application

- Apply 10^6 colony forming units (cfu) per gram of fresh forage.
- Should be applied as liquid for better coverage
- Need good coverage for inoculant to be successful
- Inoculant does not move in silage once applied.
- Should be applied at chopper, not bunker

Products for preserving Silage

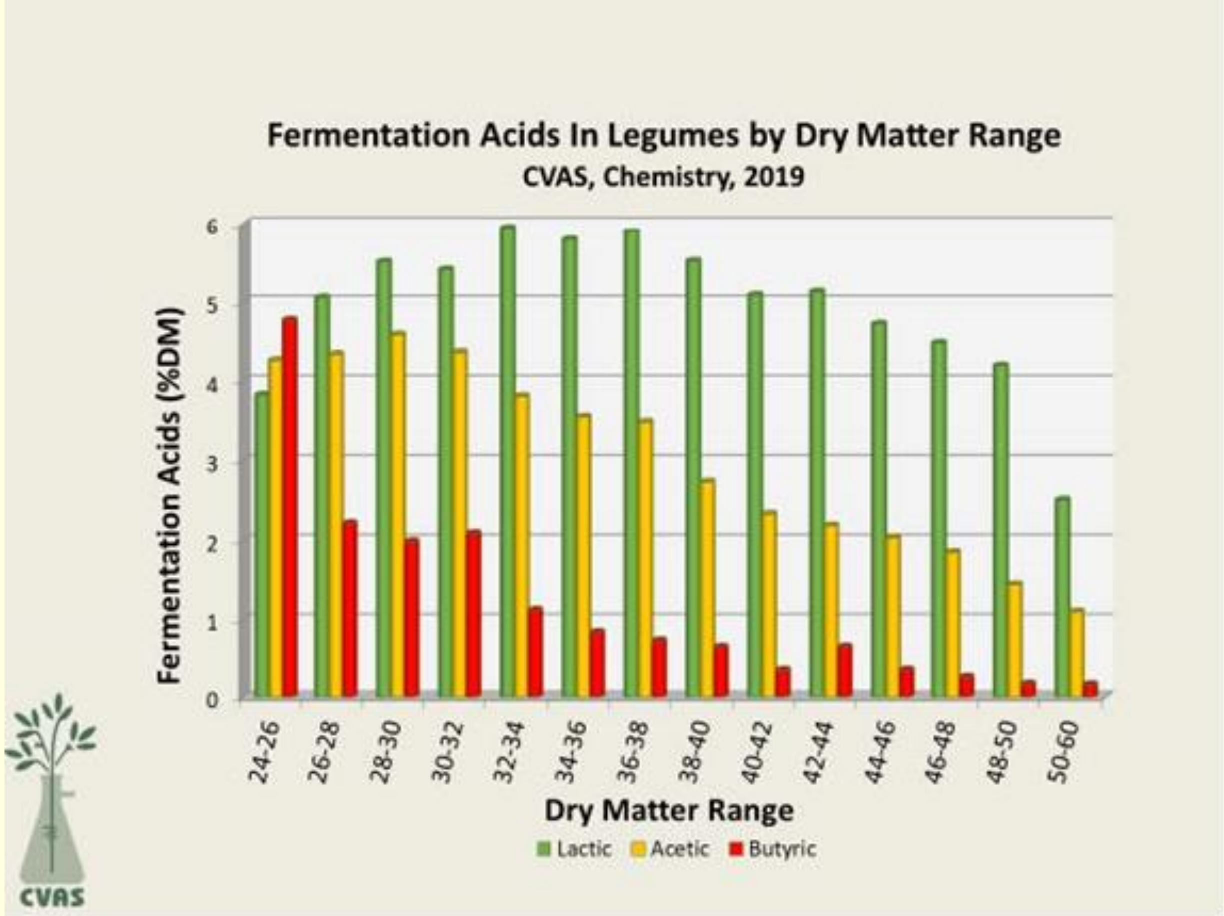
- Lactobacillus plantarium
  - use if greater than 32% DM
- Lactobacillus Buchneri
  - use if poor packing, dry matter 28 to 32%, combine with LAB
- Direct Acidification
  - Use if less than 28% dry matter

Enzymes work as well at bacteria but more expensive

Expense: Acidification > Enzymes > Buchneri > Lactobacillus plantarium


65-72%

Effect of Silage Dry Matter on acid content

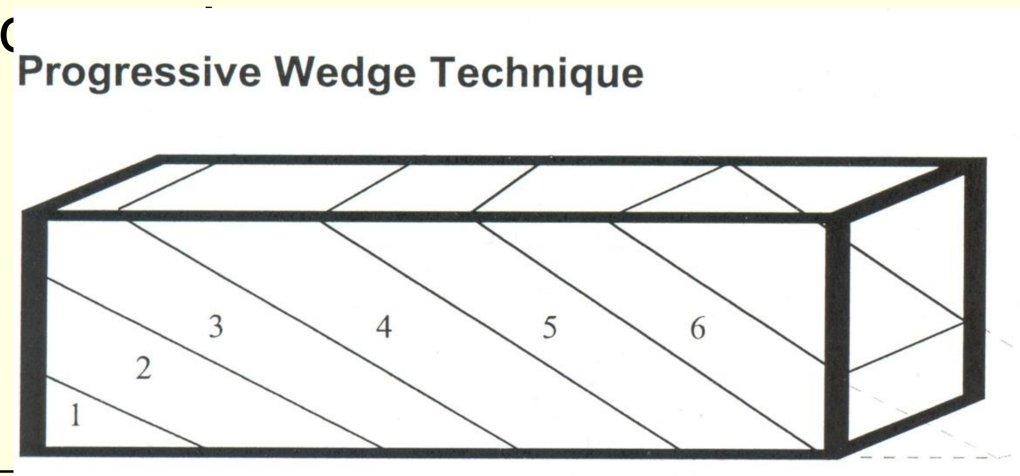


Pack Silage Well

Extension

Making good silage

- Pack well
  - Bunker 4 to 5 minutes per ton with 5800 kg tractor in 12 cm layers
  - Pack bunker in flat sections or pack bunker in pro
    wedge
  - Minimize heating



Packing to get 705 kg/m^3 or more

Bunker Silo Wall Height (meters) =		2.5	23-Aug-07
Bunker Silo Maximum Silage Height (meters) =		3.5	Values in yellow cells are user changeable
Silage Delivery Rate to Bunker (tonne AF/Hr) =		75	Typical values 15-200 t AF/hr
Silage Dry Matter Content (decimal ie 0.35) =		0.35	Recommended range of DM content = 0.3-0.4
Silage Packing Layer Thickness (cm) =		15	Recommended value is 15.24 cm or less
Packing Tractor - Each Tractor	Tractor Weight (Kg)		Tractor Packing Time (% of Filling Time)
==			
Tractor # 1	Typical tractor weight is 4,500-27,000 Kg	15000	95
Tractor # 2	Typical tractor weight is 4,500-27,000 Kg	15000	95
Tractor # 3	Typical tractor weight is 4,500-27,000 Kg	0	0
Tractor # 4	Typical tractor weight is 4,500-27,000 Kg	0	0
Proportioned Total Tractor Weight (Kg) =		28500	
Average Silage Height (meters) =		3.0	Green cells are intermediate calculated values
--			
	Packing Factor =	2977.7	Values in pink cells are results of calculations
Est. Average Wet Density = Bulk Density (kg AF/cu m) =		710.8	Wet Density greater than 705 kg AF/cu m is recommended
Maximum Achievable Bulk Density (kg AF/cu m)=		1174.6	Wet Density greater than Max. Wet Density is unrealistic
	Gas Filled Porosity =	0.39	Gas Filled Porosity less than 0.40 is recommended
Est. Average Dry Matter Density (Kg DM/cu m) =		248.8	Dry Matter Density greater than 240 Kg DM/cu m is recomm
Maximum Achievable DM Density (Kg DM/cu m)=		411.3	DM Density greater than Max. Achievable is unrealistic

Packing with 1 tractor

Bunker Silo Wall Height (meters) =	**2.5**	23-Aug-07
Bunker Silo Maximum Silage Height (meters) =	**3.5**	Values in yellow cells are user changeable
Silage Delivery Rate to Bunker (tonne AF/Hr) =	**75**	Typical values 15-200 t AF/hr
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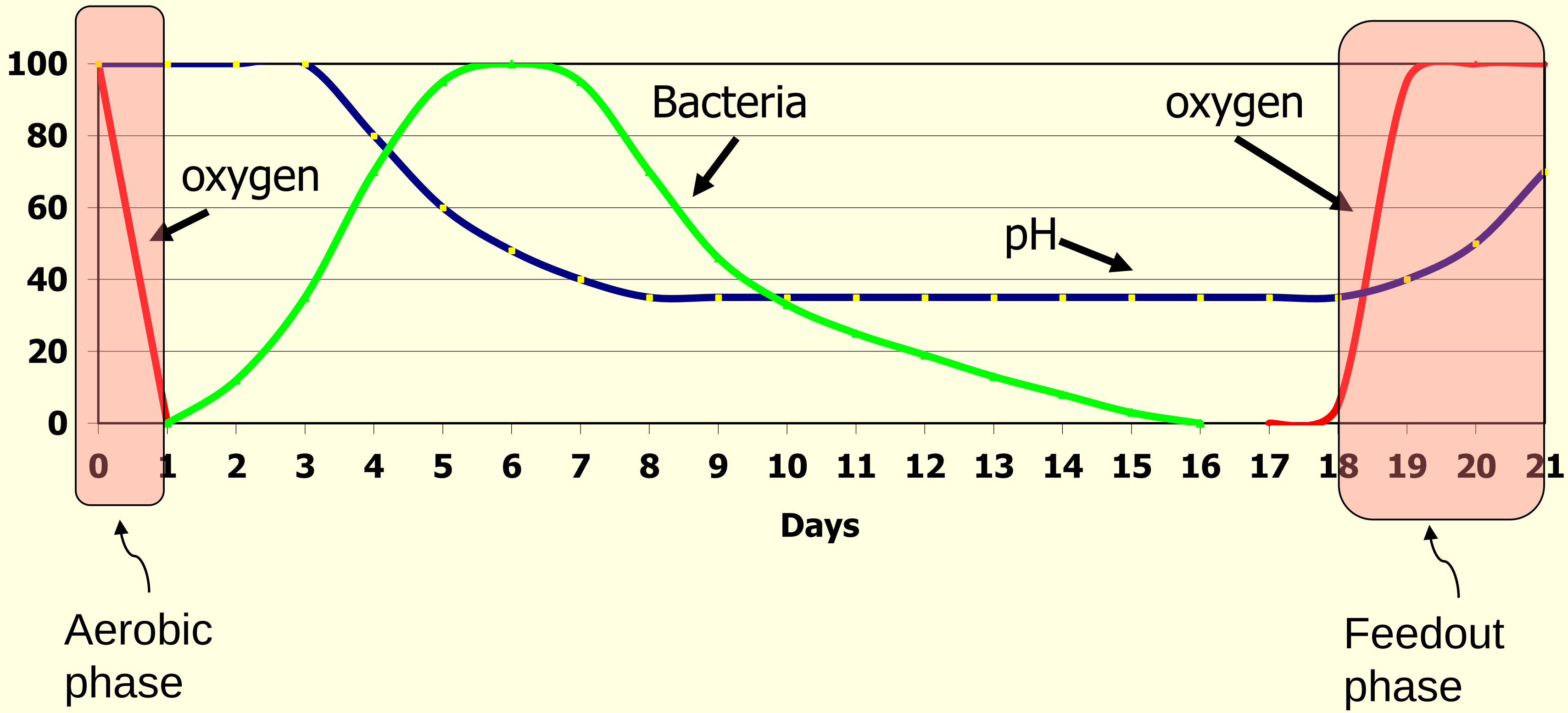
Tractor # 1 – Typical tractor weight is 4,500-27,000 Kg	**15000**	**95**
Tractor # 2 – Typical tractor weight is 4,500-27,000 Kg		
Tractor # 3 – Typical tractor weight is 4,500-27,000 Kg	**0**	**0**
Tractor # 4 – Typical tractor weight is 4,500-27,000 Kg	**0**	**0**
Proportioned Total Tractor Weight (Kg) =	**14250**	
Average Silage Height (meters) =	**3.0**	Green cells are intermediate calculated values
Packing Factor =	**2105.5**	Values in pink cells are results of calculations
Est. Average Wet Density = Bulk Density (kg AF/cu m) =	**611.1**	Wet Density greater than 705 kg AF/cu m is recommended
Maximum Achievable Bulk Density (kg AF/cu m)=	**1174.6**	Wet Density greater than Max. Wet Density is unrealistic
Gas Filled Porosity =	**0.48**	Gas Filled Porosity less than 0.40 is recommended
Est. Average Dry Matter Density (Kg DM/cu m) =	**213.9**	Dry Matter Density greater than 240 Kg DM/cu m is recomm
Maximum Achievable DM Density (Kg DM/cu m)=	**411.3**	DM Density greater than Max. Achievable is unrealistic

Phases of silage fermentation process



Take home

- Harvest at 60% to 65% moisture (35 to 40% dry matter)
- Pack silage to 705 kg/m^3
- Feed at least 30 cm/day from face of bunker/pile

Hay Preservation

- Mold growth – molds grow at 20% to 35% moisture:
  - Consume nutrients, sugars, starch
  - Respiration causes heating →hay fires
  - Produce mycotoxins
    - Detrimental to animal health
    - May decrease feed intake
  - Produce spores
    - if inhaled may cause lung disease
  - Presence reduces value of hay

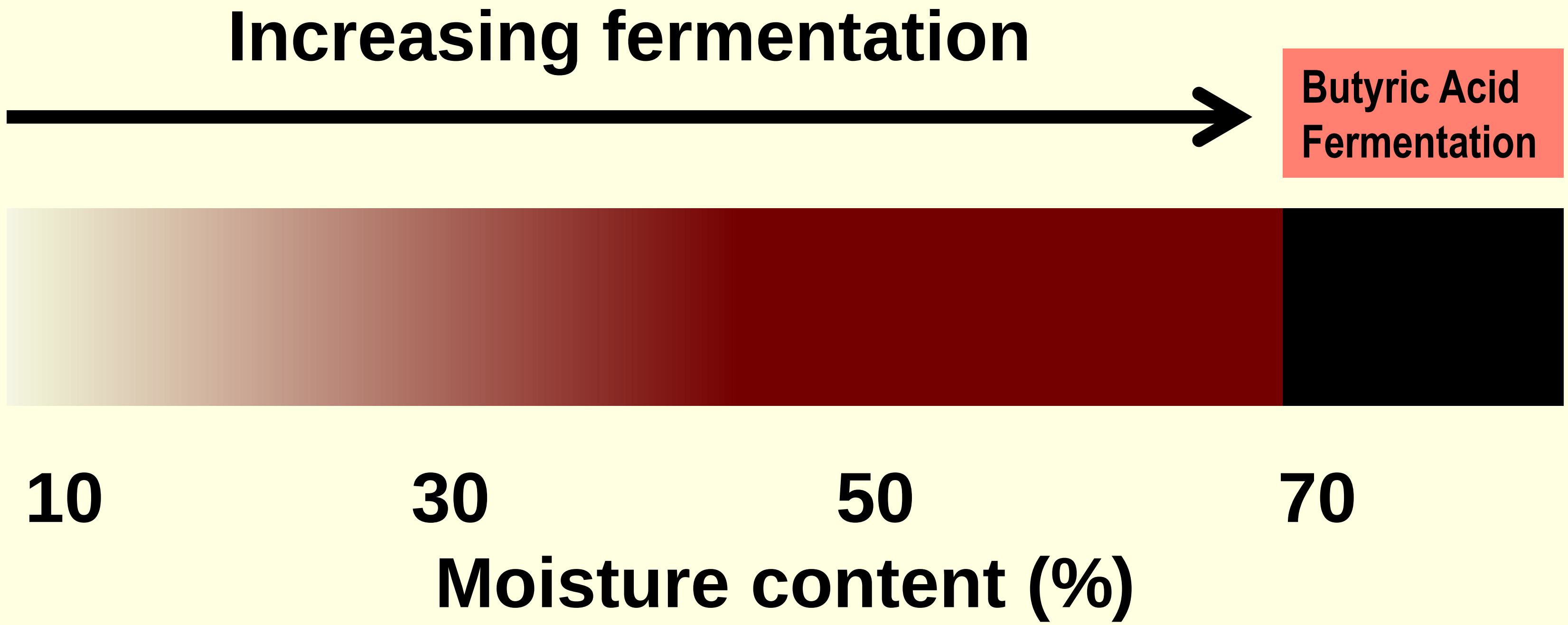
Potential Health Hazards due to Fungal Spores and Mycelia

Actinomycetes	respiratory disease, delayed allergic reactions
Absidia	mycotic abortions
Alternaria	immediate allergic reaction
Aspergillis fumigatus	mycotic abortion, respiratory disease, delayed allergic reactions
Cladosporium	immediate allergic reaction
Mucor	digestive tract ulceration
Penicillium	delayed allergic reaction
Yeast	mycotic mastitis

Wrap in plastic

- ✓Preserves by excluding oxygen
- ✓Need at least 6 wraps

Fermentation and moisture content



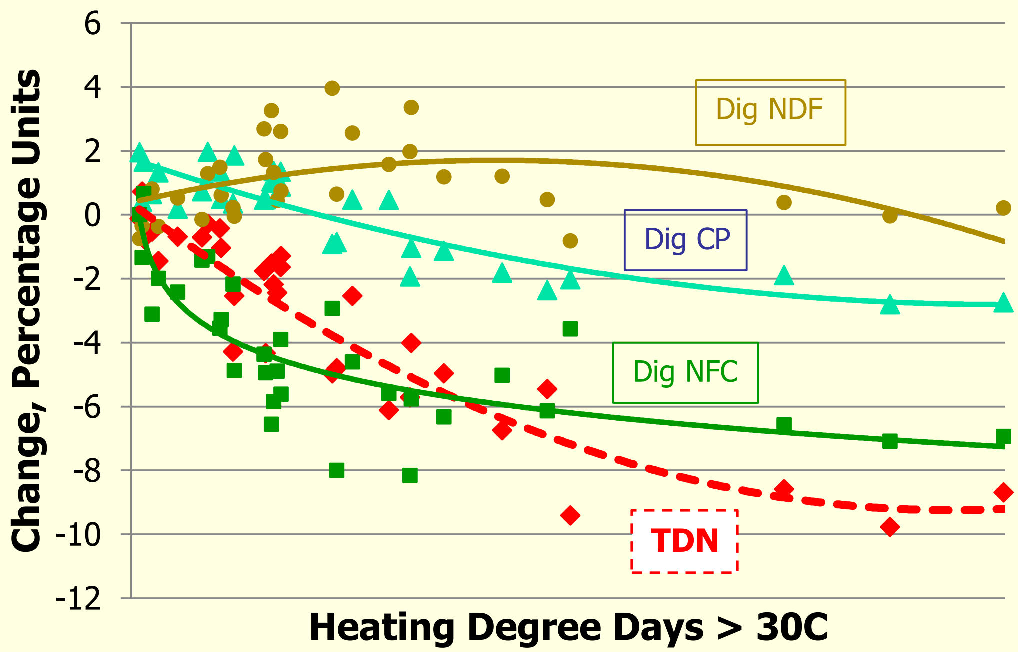
Fermentation may be important on feedout
but **not** for preservation of baleage

Wrap in plastic

- ✓Preserves by excluding oxygen
- ✓Need at least 6 wraps

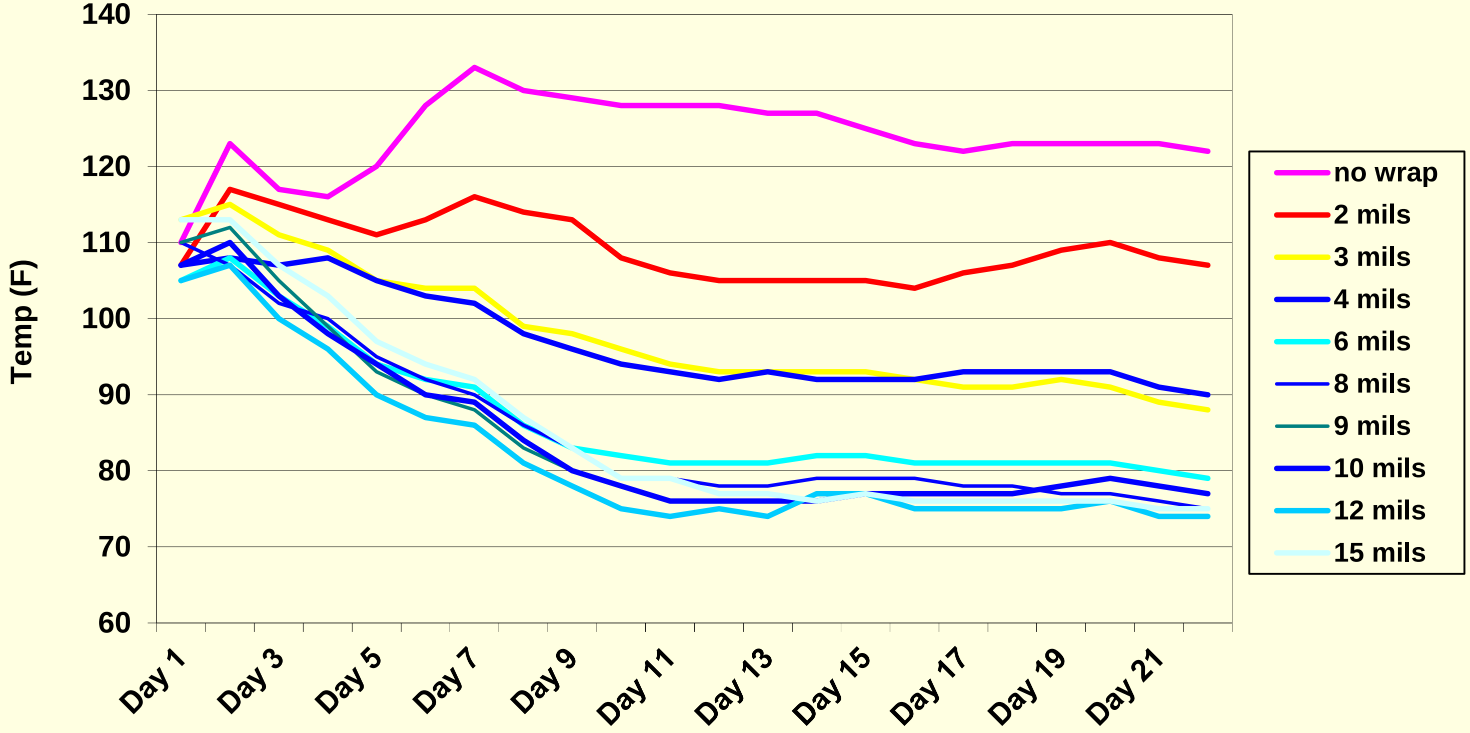
Heating in Forage
Malliard Reaction

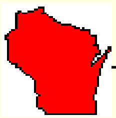
- TDN = dNFC + dCP+ 2.25*FA + dNDF - 7



How to make baleage: Wrap with 6 layers of plastic

Effect of Plastic Wrap Thickness on Internal Temperature of Bale over Time,





Lancaster, WI 1998 (30% moisture)

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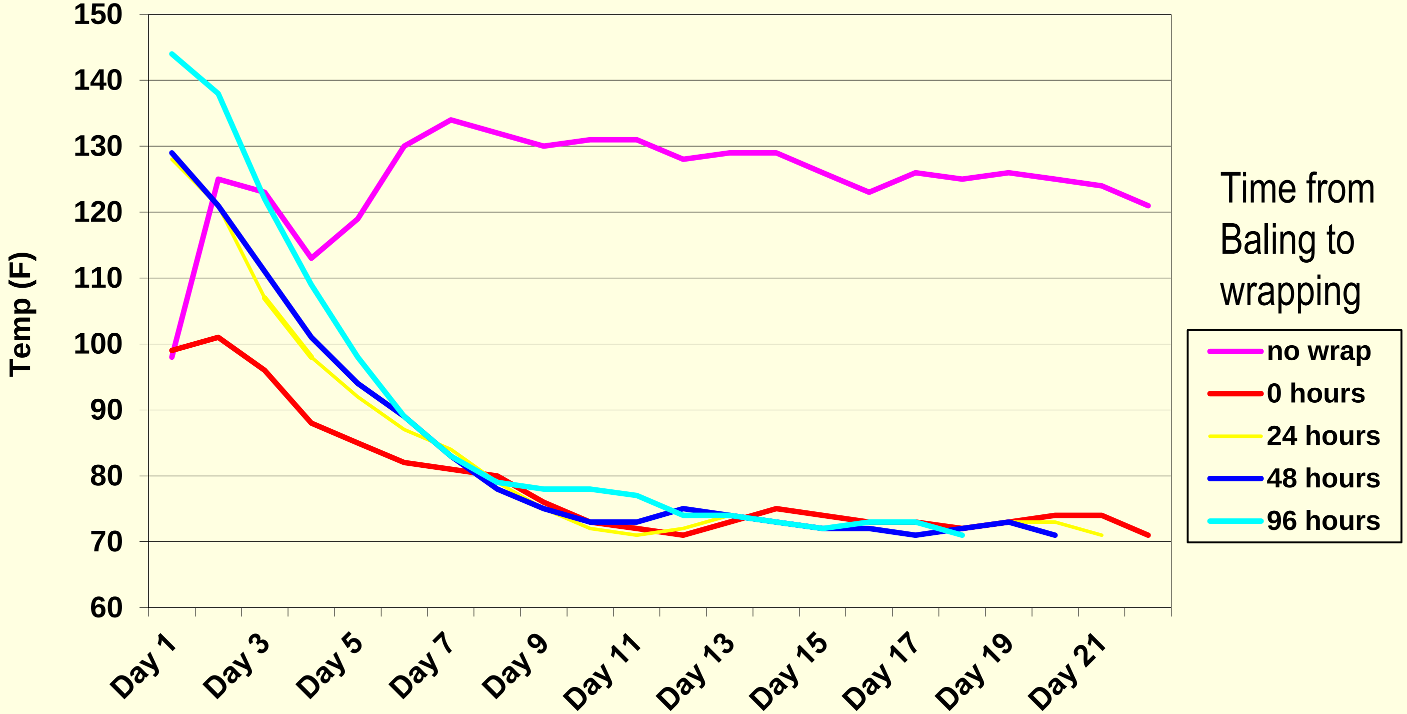
How to make baleage: Wrap Quickly after baling

Timing of Bale Wrapping effect on Internal Temperature of Bale over Time,



Lancaster, WI 1998 dry bales (36% moisture)

Avoid UV Degradation of Plastic

- Avoid oiled sisal twine
- Use plastic, untreated sisal, netwrap
- Buy good plastic for wrapping

In-Line vs individually wrapped

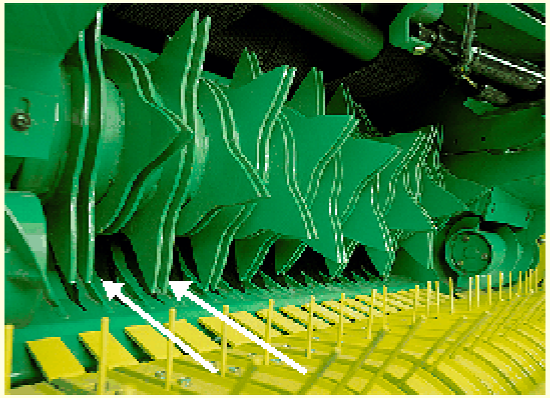
As a rule of thumb -

- individually wrapped bales is most appropriate for less than ~50 head of cattle
- above 50 to 75 head, consider in-line wrapping to reduce plastic use.

Baling

- Cutting forage for hay/haylage - bales that break apart easily for feeding
  - Higher initial cost
  - Higher energy requirement
  - Stones

✓ Better feed intake
✓ Better animal gain
✓ Less feeding loss



Minimize dirt and other debris