Hay & Silage
(some important principles)

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Outline
• Hay
  – hay versus silage principles
  – hay preservatives
• Silage
  – biology basics & proper management
  – baled silage considerations
  – inoculants

Forage Moisture Continuum

Hay vs Silage

HAY: Low moisture so respiration stops and bacteria, fungi, and yeasts cannot survive.

SILAGE: - Create anaerobic environment
  - Reduce pH to a level where bacteria, fungi, and yeast growth is inhibited.

Hay Preservatives

• Apply them so bacteria, fungi, and yeasts cannot survive
• Active ingredient: propionic and other organic acids
• What can you expect?
  – Storage similar to dry hay
  – Better palatability than dry hay
  – Slightly more storage loss than dry hay

The fermentation part of ensiling
Basics of Silage Making

Oxygen consumed by respiration
Sugars used
Heat generated

Basics of Silage Making

Oxygen supply is depleted
Acid-producing bacteria begin growth

Basics of Silage Making

No oxygen (anaerobic)
Bacteria produce acid, reducing pH
Bacteria die off after pH drops

Basics of Silage Making

pH is lowered
Microbial population is dead
Anaerobic conditions remain

Creating an Anaerobic Environment

\[ C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O + \text{heat} \]

Potential Problems
- heat generation
- reduced sugars available for fermentation
- higher dry matter losses

Proper Methods
- fill quickly
- high density (proper T/LC, moisture, bale)
- operation seal soon

Fermentation (anaerobic process)

(sugar) + (bacteria) \rightarrow (acid) + (carbon dioxide) + (ammonia) + (hydrogen)

Lactic acid producing bacteria are most desirable because they reduce pH most efficiently with least sugar consumption
Fermentation (anaerobic process)

\[(\text{sugar}) + (\text{bacteria}) \rightarrow (\text{acid}) + (\text{carbon dioxide}) + (\text{ammonia}) + (\text{hydrogen})\]

**Important Factors**
- **Moisture**
  - Too low: low density
  - Not enough moisture
  - Low specific heat
- Too high: clostridia & butyric acid effluent flow

**Bacterial Inoculants**
- **What are they?**
  - Lactobacillus bacteria applied in large numbers
- **Why use them?**
  - Complement naturally occurring bacteria
  - Increase rate of fermentation & fermentation efficiency
  - (optimal acid production without CO\(_2\) or H\(_2\) gases)
  - Reduce likelihood of clostridial fermentation which produces butyric acid
  - Potentially reduce dry matter and energy losses
  - Improve bunk life and animal performance
- **When should they be used?**
  - If naturally occurring population is low
    - Wilting temperatures are cool
    - Wilting time is short

**Potential Problems**
- **Aerobic Deterioration**
  - During stable phase
  - Air infiltrates into silage mass and yeasts, molds, etc. grow, consuming dry matter and producing heat
Potential Problems

• Aerobic Deterioration
• Clostridia Spoilage
  – undesirable bacteria from soil and manure
  – ferment lactic acid, sugars to butyric acid, carbon dioxide, and hydrogen gas
  – butyric acid is weaker, so pH rises
  – can result in toxic silage

• Aerobic Deterioration
• Clostridia Spoilage
• Lysteria
  – requires oxygen and pH above 5.5
  – results in nervous disorder, abortion, & death

• Aerobic Deterioration
• Clostridia Spoilage
• Lysteria
• Protein Solubilization
  – conversion of more crude protein to soluble protein
  – amount reduced by limiting silage temperature and achieving rapid pH drop

Baled silage checklist

- **Bale Moisture:** Proper moisture for baleage is 45 to 60%.
- **Bale Density:** Bale density should be as high as possible.
- **Bale Sealing:** Bales should be wrapped with four layers of plastic with 50% overlap. Holes should be sealed with proper tape.
- **Bale Wrapping Delay:** Bales should be wrapped within a few hours of baling.
- **Storage site:** The storage site should be constructed to minimize punctures, standing water, and rodent or bird damage.
- **Bale Stacking:** Avoid stacking of bales and, if possible, place them on their ends.
- **Forage Quality as Baled:** Forage should not be overly mature or have experienced significant rain damage.
- **Additive Use:** Inoculants should be used when wilting temperatures are cool and wilting time is short.