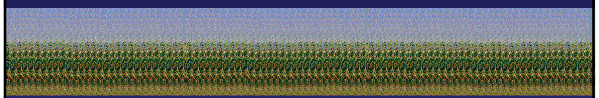


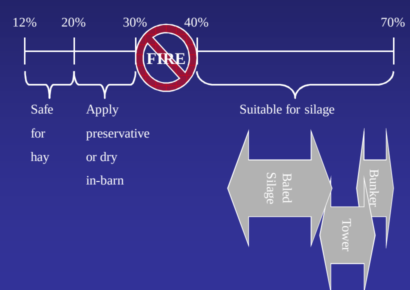
Hay & Silage
(some important principles)

Dennis Buckmaster
Ag & Biological Engineering
Purdue University

Outline

- Hay
  - hay versus silage principles
  - hay preservatives
- Silage
  - biology basics & proper management
  - baled silage considerations
  - inoculants

Forage Moisture Continuum



Hay vs Silage

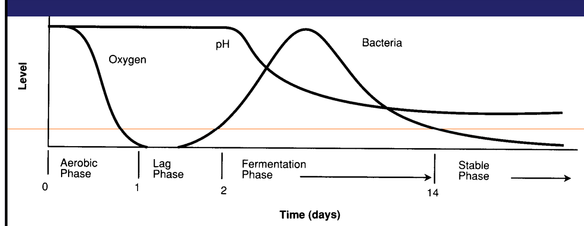
HAY: Low moisture so respiration stops and bacteria, fungi, and yeasts cannot survive.

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

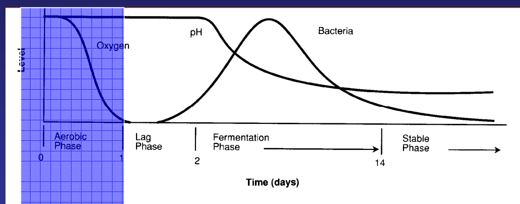
Hay Preservatives

- 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

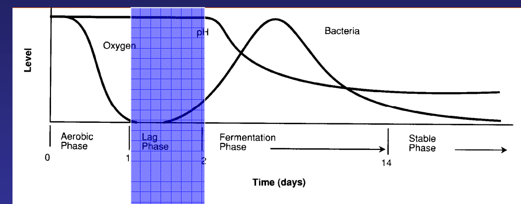


Oxygen consumed by respiration

Sugars used

Heat generated

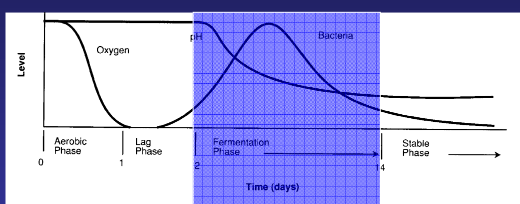
Basics of Silage Making



Oxygen supply is depleted

Acid-producing bacteria begin growth

Basics of Silage Making

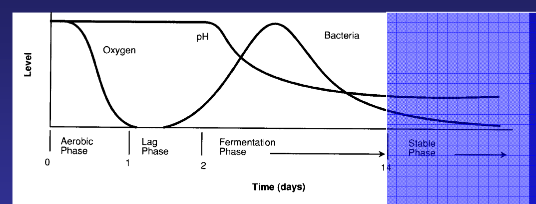


No oxygen (anaerobic)

Bacteria produce acid, reducing pH

Bacteria die off after pH drops

Basics of Silage Making

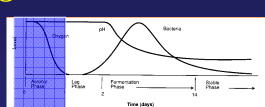


pH is lowered

Microbial population is dead

Anaerobic conditions remain

Creating an Anaerobic Environment



$C_6H_{12}O_6$ + $6O_2$ ⇨ $6CO_2$ + H_20 + heat
(sugar) (oxygen) (carbon dioxide) (water)

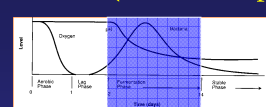
<u>Potential Problems</u>

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

<u>Proper Methods</u>

- fill quickly
- high density (proper TLC, moisture, baler operation
- seal soon

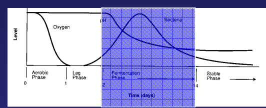
Fermentation (anaerobic process)



(sugar) + (bacteria) ⇨ (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)

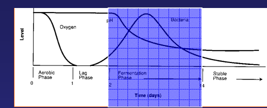


(sugar) + (bacteria) ⇨ (acid) + (carbon dioxide) + *(ammonia)* + *(hydrogen)*

Important Factors

- **Moisture**
  - **Too low: low density**
    not enough moisture
    low specific heat
  - **Too high: clostridia & butyric acid**
    effluent flow

Fermentation (anaerobic process)

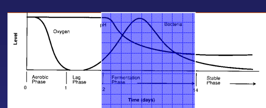


(sugar) + (bacteria) ⇨ (acid) + (carbon dioxide) + *(ammonia)* + *(hydrogen)*

Important Factors

- **Moisture**
- **Sugar: must be in sufficient supply**

Fermentation (anaerobic process)

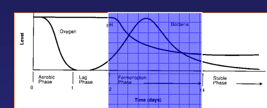


(sugar) + (bacteria) ⇨ (acid) + (carbon dioxide) + *(ammonia)* + *(hydrogen)*

Important Factors

- **Moisture**
- **Sugar**
- **Crop species: grasses generally have more sugar then legumes**

Fermentation (anaerobic process)



(sugar) + (bacteria) ⇨ (acid) + (carbon dioxide) + *(ammonia)* + *(hydrogen)*

Important Factors

- **Moisture**
- **Sugar**
- **Crop species**
- **Bacteria number and type**
  - **100 to 100,000,000 bacteria/gram naturally**
  - **homofermentative better than heterofermentative**

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

Potential Problems

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

Potential Problems

- 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

☑**Ba** … 45
to
☑**Ba** … as
po
☑**Ba** … our
lay … uld
be
☑**Ba** … pped
wi

Baled silage checklist

☑**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.