Silage Storage and Feeding Consideration

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INTRODUCTION

• Silage
  • Storage
  • Feeding

• Specials Cases
  • Nitrates and Nitrate Testing
  • Molds and Mycotoxins
SILAGE STORAGE

• Goal in making silage is to preserve nutrients for feeding at a later date
  • fermentation of plant sugars to organic acids
  • things that influence fermentation nutrient losses
    • % moisture
    • Fineness of chop
    • Exclusion of air
    • CHO content
    • Bacterial population both naturally occurring and supplemental
<table>
<thead>
<tr>
<th>Storage structure</th>
<th>Alfalfa</th>
<th>Grass</th>
<th>Corn silage</th>
<th>Small grains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal silo</td>
<td>65 – 70%</td>
<td>65 – 70%</td>
<td>65 – 70%</td>
<td>60 – 70%</td>
</tr>
<tr>
<td>Conventional Upright</td>
<td>60 – 65%</td>
<td>60 – 65%</td>
<td>63 – 68%</td>
<td>63 – 68%</td>
</tr>
<tr>
<td>Oxygen – Limiting upright</td>
<td>40 – 55%</td>
<td>40 – 55%</td>
<td>55 – 60%</td>
<td>55 – 60%</td>
</tr>
<tr>
<td>Bag</td>
<td>60 – 70%</td>
<td>60 – 70%</td>
<td>60 – 70%</td>
<td>60 – 70%</td>
</tr>
<tr>
<td>Balage</td>
<td>50 – 60%</td>
<td>50 – 60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pile or Stack</td>
<td>65 – 70%</td>
<td>65 – 70%</td>
<td>65 – 70%</td>
<td>60 – 70%</td>
</tr>
</tbody>
</table>

From Harvest to Feed: Understanding Silage Management, Penn State University
SILAGE STORAGE

From Harvest to Feed: Understanding Silage Management, Penn State University
SILAGE STORAGE

• Undesirable fermentation
  • Excessive O$_2$
    • Increases rate of CHO conversion to heat and CO$_2$
    • Decreases CHO to Lactic acid leading to energy and nutrient loss
    • Increases NDF and ADF which reduces quality and intake
    • Increases heat above 100° F
      • Decreases lactic acid producing bacteria causing protein binding lignin
      • growth and formation of bacteria, yeast and molds
SILAGE STORAGE

• Undesirable Fermentation
  • Excess heating
    • Maillard browning
      • Heating soon after ensiling
      • Protein binds to plant sugars forming brown lignin–like compound
      • Increases bound protein and ADF in silage
      • Increase temperature to the point of spontaneous combustion
    • High oxygen and high heat increase the rate that proteases convert crude protein to soluble protein
      • Creates imbalances in the rumen if not properly balanced for degradable and undegradable protein
SILAGE STORAGE

• Undesirable fermentation
  • Low plant sugar
    • Reduced production of lactic acid by lactic acid producing bacteria
      • Could result in too high of a pH restrict growth of spoilage organisms
        • This is dictated water and crop species
        • More water more sugar needed
## SILAGE STORAGE

<table>
<thead>
<tr>
<th>DM (%)</th>
<th>Alfalfa (%)</th>
<th>Grass (%)</th>
<th>Corn (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>34</td>
<td>28</td>
<td>20</td>
</tr>
<tr>
<td>20</td>
<td>25</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>25</td>
<td>21</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>17</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>35</td>
<td>14</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>45</td>
<td>7</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Typical range</td>
<td>4-15</td>
<td>10-20</td>
<td>8-30</td>
</tr>
</tbody>
</table>


1Boxes indicate dry matter range over which typical sugar contents are sufficient for maximum fermentation.

2Sugar content expected at harvest.
SILAGE STORAGE

• Undesirable fermentation

  • Butyric acid production phase
    • Formation of Clostridia bacteria
      • Butyric acid, CO₂, H₂, ammonia, amines, putrescine, cadavarine
      • Raise pH
    • Sour smelling low energy acid that tends to decrease feed intake
    • Increases loss of digestible DM, decrease palatability
SILAGE STORAGE

• Undesirable fermentation
  • What sets the stage for butyric acid stage production
    • Moisture content greater than 70 to 72% and low initial CHO level
    • Silage characteristics
      • pH > 5, high ammonia – nitrogen levels, more butyric acid than lactic acid and strong unpleasant odor
    • Cows will go off feed, decreased milk production and metabolic disorders
### Silage Storage

<table>
<thead>
<tr>
<th>Species</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. tyrobutyricum</em></td>
<td>Ferment sugars and lactic acid.</td>
</tr>
<tr>
<td><em>C. sphenoides</em></td>
<td></td>
</tr>
<tr>
<td><em>C. bifermentans</em></td>
<td>Ferment amino acids.</td>
</tr>
<tr>
<td><em>C. sporogenes</em></td>
<td></td>
</tr>
<tr>
<td><em>C. perfringens</em></td>
<td>Ferments sugars, lactic acid, and amino acids. May produce toxins that cause enterotoxemia.</td>
</tr>
<tr>
<td><em>C. botulinum</em></td>
<td>May produce toxins that result in death.</td>
</tr>
</tbody>
</table>


*C.* indicates *Clostridium.*
SILAGE STORAGE

• Achieving adequate density
  • Depends on plant species, crop maturity, moisture content, length of cut, silo type, filling method, distribution and compaction
  • Greater density
    • reduces dry matter loss by decreased air penetration in storage and feed out
    • Increase silo capacity and reduces storage cost per ton
## SILAGE STORAGE

<table>
<thead>
<tr>
<th></th>
<th>Alfalfa haylage (87 silos)</th>
<th>Corn silage (81 silos)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg. ± SD(^1)</td>
<td>Range</td>
</tr>
<tr>
<td>Dry matter, %</td>
<td>42 ± 10</td>
<td>24–67</td>
</tr>
<tr>
<td>Bulk density, lb/ft(^3)</td>
<td>37 ± 11</td>
<td>13–61</td>
</tr>
<tr>
<td>Dry density, lb DM/ft(^3)</td>
<td>14.8 ± 3.8</td>
<td>6.6–27.1</td>
</tr>
<tr>
<td>Particle size, inches</td>
<td>0.46 ± 0.15</td>
<td>0.27–1.23</td>
</tr>
</tbody>
</table>


\(^1\)Average and standard deviation.
SILAGE STORAGE

• Adequate Bulk Density

  • 40 lb/ft$^3$ (14 lb DM/ft$^3$ density)
    • bulk density 30 lb/ft$^3$
      • Increase in oxidation molds and spoilage
    • bulk density of 62.4 lb/ft$^3$
      • Seepage which greatly reduces water soluble nutrients occurs
      • This will also occur if moisture content is greater than 70 to 75%
SILAGE STORAGE

- Seal rapidly and tightly
  - Air exposure delays pH drop and leads to spoilage
  - Rain will leach nutrients
  - Should be sealed immediately to prevent air infiltration including edges and slope end of horizontal silo
    - Use tires at a rate of 0.25 tires per square feet
  - Check plastic every 2 wk and fix holes if needed
CORN SILAGE DRY MATTER RECOVERED AT THREE DEPTHS AFTER 180 DAYS IN SMALL BUNKER SILOS

SILAGE STORAGE

• Filling and packing horizontal silo
  • Using a progressive wedge technique
    • Push silage up face forming a slope with a 30 to 40% slope and layers 6 in deep
      • exposes less surface area
      • thin layers for better compaction
    • Someone should be totally devoted to packing silage when filling
SILAGE STORAGE

• Use wheel type tractor vs crawler type tractor
  • Wheel concentrates weight over smaller area increase pressure
• Stop packing ½ hour after last load and start packing ½ hour before first load
SILAGE STORAGE

• Safety
  • Keep respectable distance from the unsupported edges
  • Use tractors with ROPS and wear seat belt
  • Don’t back off silage pile, back onto pile and drive off

• Complete silo filling by
  • Crown silage one eighth of the silo width
    • Diverts precipitation away from silage mass
    • Higher moisture silage on top to make a tighter pack
SILAGE STORAGE

• Silo bags
  • Integrity of bag is important
  • Set on site with good drainage away from open end of bag
  • Weed free to keep rodents away
  • Every 2 wks inspect for holes and fix if present
  • DM Capacity, Volume of silage, and DM density
    • Volume = 3.14 X (Diameter^2/4) X Length of silage
      • When full length bags are used length of silage = bag length – unused portion required to the seal end of bag
    • DM Capacity = Volume X DM density
SILAGE STORAGE

• Silage piles
  • Low cost
  • Similar management to bunker silos
    • Packing and covering the pile
  • Piles wide and low
    • 3 ft length of 1 ft high with a max of 18 to 20 ft high
  • Plan feeding face to limit the exposed surface and removal rate higher than traditional bunker silos
FEEDING MANAGEMENT

Factors that influence bunk life

- Oxygen = levels < 5%
- CO₂ = levels >20%
- Spoilage organisms
  - Yeast mold and aerobic bacteria
- Temperature
  - Microbial growth between 40° to 110° F
- Inadequate fermentation
  - Residual or Unfermented water soluble CHO provides food for spoilage organisms
- Forage Dry matter
  - Dry is less time
FEEDING MANAGEMENT

• Controlling spoilage at the exposed face
  • Removal rate must be ahead of spoilage
    • Correctly size storage structure to animal needs
  • Tighter the pack the better
  • Remove Silage evenly from the entire face
    • Remove from the top down or shear side to side
    • Scoop load from bottom and chip from the top to the opening
    • Avoid lifting from the bottom which creates cracks and allows air to penetrate
# Table 18. Recommended minimum removal rate (inches per day) by storage type.

<table>
<thead>
<tr>
<th>Storage type</th>
<th>Daily high ≤ 40°F</th>
<th>Daily high &gt; 40°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsealed upright</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Sealed upright</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Horizontal¹</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Silo bag¹</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Stack or pile¹</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

¹Increase these rates for silage with dry matter density less than 14 lb/ft³ (bulk density less than 40 lb/ft³).
FEEDING MANAGEMENT

- Remove only what you need to feed at that time
- Clean up everything and don’t leave piles around
- Design silos to face from prevailing winds and hot afternoon sun
FEEDING MANAGEMENT

• Controlling Spoilage at the bunk
  • Keep silage fresh at the bunk, clean and remove uneaten feed daily, keep water out of the bunk
  • During hot weather
    • Feed multiple times per day, limit wet ingredients in ration, mix for one feeding
RATION BALANCING

- Nutrient requirements of the animal
- Test the silage to determine nutrient value
- Formulate the ration to meet animal requirements
  - Protein and Energy
  - Vitamins and minerals
- Remember to evaluate silage for special issues and feed accordingly
<table>
<thead>
<tr>
<th>Feed Stuff</th>
<th>% DM</th>
<th>%TDN</th>
<th>%CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Silage Milk Stage</td>
<td>26</td>
<td>65</td>
<td>8</td>
</tr>
<tr>
<td>Corn Silage Mature Well Eared</td>
<td>34</td>
<td>72</td>
<td>8</td>
</tr>
</tbody>
</table>
### WHAT NUTRIENT NEEDS DO CATTLE HAVE?

<table>
<thead>
<tr>
<th>Type of Cattle</th>
<th>Pounds Dry Matter Per Day</th>
<th>% TDN</th>
<th>% Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200 lb. cow mid-pregnancy</td>
<td>21</td>
<td>50</td>
<td>7.1</td>
</tr>
<tr>
<td>1200 lb. cow last 1/3 pregnancy</td>
<td>24</td>
<td>54</td>
<td>7.9</td>
</tr>
<tr>
<td>1200 lb. cow lactation avg. milk producer</td>
<td>30</td>
<td>58</td>
<td>9.8</td>
</tr>
<tr>
<td>1200 lb. cow lactation high milk producer</td>
<td>32</td>
<td>59</td>
<td>10.5</td>
</tr>
<tr>
<td>1120 lb. replacement heifer last 1/3 pregnancy</td>
<td>23</td>
<td>58</td>
<td>8.9</td>
</tr>
<tr>
<td>1120 lb. lactating heifer - avg. milk producer</td>
<td>27</td>
<td>62</td>
<td>10.4</td>
</tr>
<tr>
<td>500 lb. calf-gaining 1.5 lbs. per day</td>
<td>12.6</td>
<td>64</td>
<td>11.2</td>
</tr>
<tr>
<td>500 lb. calf-gaining 2.0 lbs. per day</td>
<td>12.7</td>
<td>69</td>
<td>12.8</td>
</tr>
<tr>
<td>600 lb. calf-gaining 1.5 lbs. per day</td>
<td>14.4</td>
<td>64</td>
<td>10.6</td>
</tr>
<tr>
<td>600 lb. calf-gaining 2.0 lbs. per day</td>
<td>14.6</td>
<td>69</td>
<td>11.9</td>
</tr>
<tr>
<td>2000 lb. mature bull gaining 0.5 lbs.</td>
<td>40</td>
<td>50</td>
<td>7.0</td>
</tr>
</tbody>
</table>
FEEDING STRATEGIES

- Start them slow on it and work them up on it
- Remember that it is 26 to 34% DM
- Feeding levels
  - Typically 12 to 15 lbs of DM in the ration
  - Could go to a 1/3 to 1/2 of the ration on DM basis
  - Make sure you are meeting the animals requirements
- If there is a nitrate or mycotoxin issue feed the correct level
SPECIAL CASES

• Nitrate poisoning
  • Accumulates in lower stalks during dry weather
  • Avoid high rates of nitrates
  • Does not dissipate
  • Present in corn, milo / sorghum stalks
• Making silage could reduce the level of nitrate 20 to 50%
SPECIAL CASES

Nitrate Toxicity Cause

Nitrate $\xrightarrow{}$ Nitrite $\xrightarrow{}$ ammonia $\xrightarrow{}$ Microbial protein

Accumulation

Conversion of Hemoglobin to Methemoglobin

Lack of oxygen carrying capacity from lungs to tissues

Urea and NPN supplements

Nitrate inhibits the action of the enzyme which breaks urea down into ammonia, delaying and leveling rumen ammonia supply
Cattle Nitrate Toxicity Symptoms

- Difficult, painful, and rapid breathing
- Muscle tremors
- Incoordination
- Diarrhea
- Frequent Urination
- Dark to chocolate colored blood
- Abortions
- Decreased milk production
- Collapse
- Death
SPECIAL CASES

• Testing Silage for high nitrate
  • Extension office spot test on stalks prior to harvest
  • Send off to have a test done
    • Defined level
    • Feeding instructions based on the level
## SPECIAL CASES

<table>
<thead>
<tr>
<th>% NO₃</th>
<th>Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00-0.44</td>
<td>Consider Safe for all classes of cattle</td>
</tr>
<tr>
<td>0.44-0.66</td>
<td>Safe for non-pregnant animals</td>
</tr>
<tr>
<td>0.66-0.88</td>
<td>Limit to 50% of dry matter</td>
</tr>
<tr>
<td>0.88-1.54</td>
<td>Limit to 35 to 40% of dry matter</td>
</tr>
<tr>
<td>1.54-1.76</td>
<td>Do not feed to pregnant animals</td>
</tr>
<tr>
<td>1.76 and up</td>
<td>Limit to 25% of the total dry matter in other classes</td>
</tr>
</tbody>
</table>

SPECIAL CASES

• Mycotoxin
  • Aflatoxin
    • Reduced appetite, reduced growth or milk production, rough hair coat, immunosuppression
  • Action levels
    • Finishing beef cattle corn and peanut products = 300 ppb
    • Beef cattle cottonseed meal = 300 ppb
    • Breeding cattle corn and peanut products = 100 ppb
    • Immature animals, animal feeds, and ingredients = 20 ppb
SPECIAL CASES

- Mycotoxin
  - Vomitoxin
    - Experiments looking at effects of vomitoxin on beef cattle performance and health showed to be negligible
    - FDA Recommended level is less than 10 ppm in corn and corn byproduct feeds and 5 ppm in finished feeds
SPECIAL CASES

• Mycotoxins
  • Zearalenone
    • Estrogenic Response
      • Abortions, repro tract infections, poor conceptions, mammary gland enlargement in heifers
    • Reduce feed intake and milk production
  • No FDA action
    • Toxic level observation based and 200 to 300 ppb
SPECIAL CASES

- Mycotoxins
  - T-2 Toxin
    - Decrease feed intake and milk production
    - Infections of the GI tract and intestinal hemorrhage
    - Death
    - Avoid levels above 100 ppb
SPECIAL CASES

- Mycotoxins
  - Fumonisin
    - toxicity results from blockage of sphingolipid biosynthesis and thus degeneration of tissues rich in sphingolipids
    - Liver damage
    - Decreased feed consumption and milk production
    - Carcinogenic
    - Recommended FDA level is for breeding ruminants 15 ppm and slaughter ruminants 30 ppm
SPECIAL CASES

• Mycotoxins
  • Ochratoxin
    • Kidney damage
    • Rapidly degraded in the rumen so problem for preruminant calves
    • No FDA action
SPECIAL CASES

• Mycotoxin
  • Testing
    • Find a lab close by
      • https://www.msu.edu/user/mdr/Myco_Analysis_Labs.pdf
      • MU Extension specialist may be able to help you in identifying a lab
CONCLUSION

• Goal is to produce high quality silage to feed to livestock as efficiently as possible
  • Follow proper protocols for storage and feeding
  • Reduce losses at storage and feeding
• Make sure you are meeting the animals requirements and supplement as needed
• Identify if silage may be high in nitrate or mycotoxins and if so feed accordingly
REFERENCES

From Harvest to Feed: Understanding Silage Management, Penn State University

University of Kentucky College of Agriculture Cooperative Extension Service Guide Sheet ID-121

Silage Bag Capacity. Holmes, B.J., Biological Systems Engineering Department, College of Agricultural and Life Sciences, University of Wisconsin – Madison

Mold and Mycotoxin Issues in Dairy Cattle: Effects, Prevention and Treatment. L.W. Whitlow and W.M. Hagler, Jr., North Carolina State University
REFERENCES

http://www.fda.gov/AnimalVeterinary/Products/AnimalFoodFeeds/Contaminants/ucm050974.htm

Feed Composition Table 2012, Beef Magazine, March 2012
QUESTIONS

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