Silage Harvest Moisture and Proper Fermentation

- Corn harvested for silage should be fermented quickly and carefully to help ensure the highest quality silage is produced.
- The production of lactic acid helps to ferment the ensiled crop efficiently by actively dropping the pH.
- Corn silage quality is more accurately determined by moisture content than corn maturity stage. However, understanding both aspects can help in determining when to begin harvest.

Silage is produced to help maintain forage nutrition for feeding livestock well beyond the harvest date. In order to accomplish this, plant carbohydrates (sugars) are converted through fermentation into organic acids. Nutrient loss can be minimized through proper management of the following silage components:

- Harvest moisture content
- Chop fineness
- Air elimination
- Carbohydrate content
- Bacterial population

Harvest Moisture

There are several reasons why it is critical to harvest silage at the proper moisture content and stage of maturity, including:

- Increased nutrient yield potential
- Reduced losses in the field and in storage
- Increased animal consumption and palatability
- Reduced seepage

Corn should be harvested when the whole-plant moisture is around 55 to 70 percent. Exact moisture content depends on the storage method used (Table 1).

<table>
<thead>
<tr>
<th>Storage Structure</th>
<th>Recommended Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal silo</td>
<td>65-70%</td>
</tr>
<tr>
<td>Conventional upright</td>
<td>63-68%</td>
</tr>
<tr>
<td>Oxygen-limiting upright</td>
<td>55-60%</td>
</tr>
<tr>
<td>Bag</td>
<td>60-70%</td>
</tr>
<tr>
<td>Pile or stack</td>
<td>65-70%</td>
</tr>
</tbody>
</table>


Corn silage quality is more accurately determined by moisture content than corn maturity stage, but understanding both qualities can help when determining when to harvest. The milk line is indicated by a whitish line that divides the kernel starch and milk. At one-quarter milk line, the line will exist 25 percent down from the top of the kernel (Figure 1), and all kernels will be dented. At one-half milk line, the corn crop will be around 65 percent moisture, and at three-quarter milk line and at black layer, moisture content will be around 55 to 60 percent moisture. As the corn approaches black layer, grain content increases, but starch digestibility decreases. For more digestible corn that is higher in nutrition, silage corn should be harvested around one-half milk line.

Once silage corn maturity enters one-quarter milk line, whole plant moisture can be tested and used to help decide when to harvest. One-quarter milk line typically occurs when the corn crop is around 70 percent moisture content. A corn crop dries down approximately 0.5 to 0.6 percent per day. This drydown rate coupled with the moisture content and the type of storage being used, can be used to determine the optimal day to begin silage harvest. For example, if corn moisture content is 70 percent moisture, and the ideal moisture content is 65 percent, then a total of 5 percent moisture drydown is needed. When multiplied by 0.5 to 0.6 percent drydown per day, a 5 percent drydown results in 8 to 10 days until harvest. Moisture content should be checked again at harvest.

Fermentation

A recently harvested forage crop can be converted to silage within 21 days of ensiling. The crop will move through four phases of normal fermentation.

**Plant respiration.** The first phase occurs once the forage is cut and can only occur when oxygen is present. Plant cells will continue to respire and plant enzymes will continue to breakdown proteins. This, coupled with the growth of naturally-occurring aerobic bacteria, will deplete readily available carbohydrates, producing carbon dioxide, water, and heat. Silage temperature may elevate to 20 °F higher than the ambient temperature.

Based on the amount of oxygen present, plant respiration may continue for three to five hours. To reduce consumption of carbohydrates, oxygen should be removed quickly and throughout storage. This can be accomplished by harvesting at the proper moisture content, chopping forage at between 3/8 to 3/4 of an inch, packing well-compacted silage evenly, and immediately sealing the storage system after ensiling.

**Production of acetic acid.** In the absence of oxygen, acetic acid-producing bacteria begin to multiply during the second phase of fermentation. These bacteria convert carbohydrates from the forage to acetic acid. This process acidifies the plant material, which lowers the pH...
from around 6.0 to 5.0. The acetic acid-producing bacteria cannot tolerate the lower pH, and their population begins to drop. Plant enzyme activity also begins to decline in the acidic environment.

**Production of lactic acid begins.** As the pH of the forage material declines during the third phase of fermentation, lactic acid-producing bacteria begin to multiply. Lactic acid-producing bacteria that are heterofermentative convert forage carbohydrates into lactic acid, acetic acid, ethanol, mannitol, and carbon dioxide. Heterofermentative bacteria are usually prevalent in the beginning, but as the pH of the material drops, the more efficient homolactic bacteria increase in population. Bacteria that are homolactic are capable of producing only lactic acid, which can help accelerate the process and reduce the production of unnecessary byproducts.

**Maximum production of lactic acid and storage.** The last phase of normal fermentation continues lactic acid production until the pH drops low enough that no bacterial growth occurs. For corn, the pH will range from 3.5 to 4.5. The silage material is typically stable after 21 days, and fermentation will stop as long as no outside air enters the storage area. Silage should continue to be stored without oxygen to help restrict the growth of yeast and mold. The acidic environment helps to prevent bacterial growth in the silage material.

**Improper Fermentation**

Several situations can lead to improper fermentation. Too much oxygen can lead to an accelerated conversion of carbohydrates into heat and carbon dioxide, which will lead to silage nutrient and energy loss. Heat can result in the growth of bacteria, yeasts, and molds.

If oxygen is limited, and available plant carbohydrates are also limited, then the mass can begin production of butyric acid. The most prevalent butyric acid-producing bacteria are Clostridia species. These bacteria deplete the silage of any surplus carbohydrates, proteins, or sugars, in addition to the desirable acids produced in previous fermentation phases. The result is a silage with a sharp odor, low nutrition, low palatability, and low digestibility. Butyric acid production can occur more frequently when silage is stored at a higher moisture content (higher than 70 to 72 percent), or with silage that is low in available carbohydrates.

**Sources**


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