

Maximizing Silage Quality

Best Practices for Silage Production

Silage is harvested immature forage that is preserved to maintain feed quality. When considering silaging a crop, it is important to prepare in advance to ensure the availability of proper equipment and storage and to implement appropriate harvesting methods. With effective management, silage can serve as a high-quality feed with minimal harvest loss and can increase profitability.

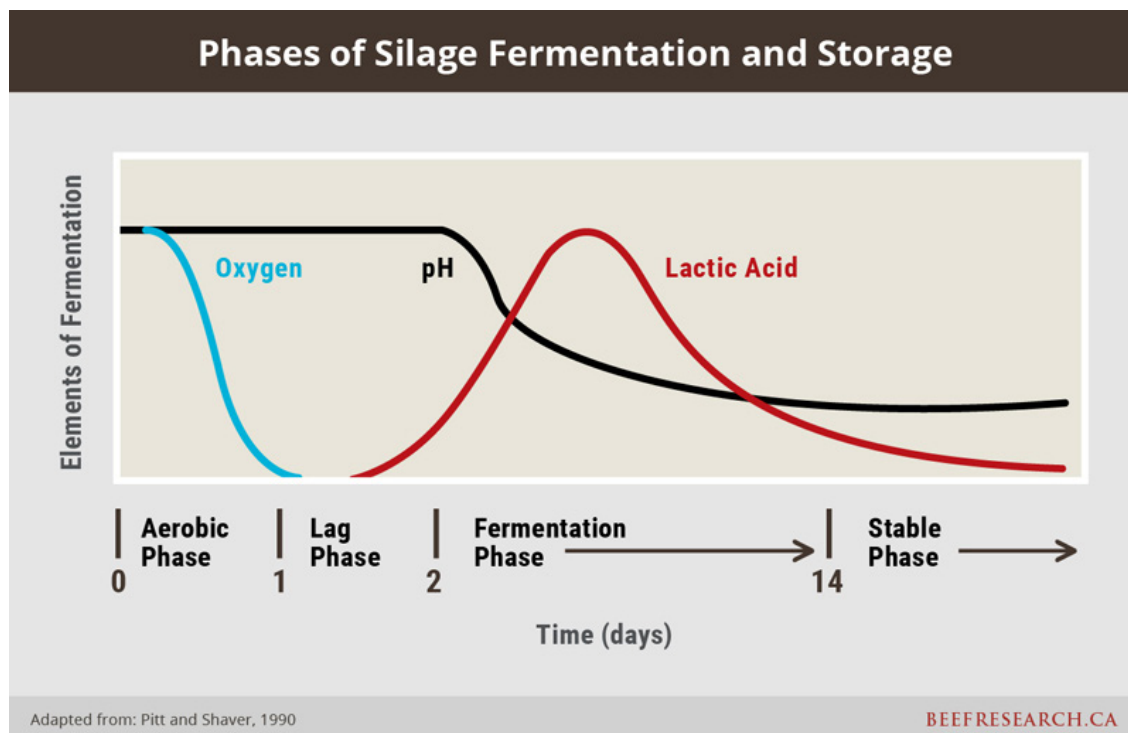


Figure 1. Fermentation Phases with permission from Beef Cattle Research Council

The ensiling process consists of the four phases shown in Figure 1. The first is the aerobic phase, where the plants use available oxygen, reducing the presence of aerobic bacteria. This phase should be brief, as a rapid decline in pH favours the growth of anaerobic bacteria during the remaining phases that thrive in oxygen-depleted conditions. Ensuring a successful ensiling process depends on a quick removal of oxygen from the plant material and a rapidly lowered pH. After approximately four weeks, the pH stabilizes, limiting further bacterial growth. This stable phase ensures the preservation of silage during storage and the feedout phase.

Cutting and Harvest Management

Before cutting, determine the desired stage of crop maturity to ensure adequate moisture content and sufficient water-soluble carbohydrates for successful fermentation. Target moisture content for pit silage is 65 per cent, while the target moisture content for silage bales is 50 per cent. Lactic acid bacteria require sufficient water-soluble carbohydrates to lower the pH to optimal levels. Harvesting when moisture is too high can cause seepage, resulting in greater losses of energy and protein. Harvesting when moisture is too low can lead to spoilage and heating.

Table 1. Recommended harvest time for various crop types based on water soluble carbohydrates (WSC) and moisture content (%)

	WSC	Stage of Maturity	Moisture ^a , %	
			Silage Pit	Silage Bales
Annual Cereals	High	Soft to hard dough	55 - 65	45 - 55
Peas	Low	Earliest pods are wrinkled	65 - 70	40 - 55
Corn	Moderate	50% milk line	60 - 70	45 - 55
Warm-Season Grasses	Low	Dough stage	60 - 70	45 - 55
Perennial Grasses	Adequate	Late boot to early heading	60 - 70	45 - 55
Legume Crops	Low	Early to mid-bloom	60 - 70	55 - 60

^a Moisture percentage of each crop is dependent on stage of maturity, and method of ensiling. Adapted from British Columbia Ministry of Agriculture and Province of Manitoba.

The recommended chop length is approximately half inch to ensure the crop is cut in short, uniform pieces. If the crop is too mature or moisture content is below 55 per cent, decrease the chop length to allow for adequate packing. Dry matter can be tested using the microwave method. To use the microwave method:

1. Use a weigh scale, weigh a microwavable plate and record the weight.
2. Add 100 g of silage to the plate and record the combined weight of the plate and the silage. Place plate with the forage in the microwave for four minutes.
3. Take the plate of forage out of the microwave and record the weight. Place the plate of silage in the microwave for another two minutes.
4. Repeat Step 3 until the weight of the plate of silage is unchanged.
5. Subtract the weight of the plate from the combined weight of the plate and silage to determine the dry weight of the silage. Use the weights of the wet and dry silage and place into this equation:

$$DM\% = \frac{\text{Dry Silage Weight}}{\text{Wet Silage Weight}} \times 100$$



Figure 2. Ideal crop length

Inoculants and Additives

Silage inoculants and additives can enhance the fermentation process by increasing available carbohydrates or lactic acid bacteria. However, proper management should remain the top priority when making silage, as inoculants and additives are not substitutes for good ensiling procedures. The use of silage inoculants has been shown to improve fermentation and animal performance across various crops. Inoculants can be applied in granular and liquid forms. It is crucial to use quality water for mixing, as elevated chlorine levels can harm beneficial bacteria. The use of enzymes as silage additives has shown inconsistent results in improving fermentation and animal performance; therefore, careful evaluation is necessary when selecting products.

Storage

During storage it is important to minimize exposure to air during the ensiling and feedout phase to prevent spoilage and maximize feed quality. Chopped plant material should be added to the ensiling area as quickly as possible to prevent excess oxygen exposure, which can lead to spoilage. Packing between layers during ensiling is recommended for horizontal silage storage methods, such as in a pit or bunker, to expel and exclude air.

Common storage methods include trench, bunker, oxygen-limiting silos, heap silage, and baleage. Capital costs vary with each method, and it is important to consider what works best for the operation.

- **Baled Silage:** a silaging method where high-moisture bales are put into an airtight plastic wrap. The maximum time a bale should sit before wrapping is 12 hours. Extended time between baling and wrapping can lead to spoilage instead of fermentation. Standard hay equipment may be used; however, consideration of bale size is essential due to greater bale weight for high moisture forages, making it difficult for equipment to handle the bales. Silage balers are ideal for baleage, as they are designed to handle heavy, high moisture forages. Additionally, silage balers have knives to achieve the desired chop length.
- **Silage Bunker:** chopped forage is hauled from the silage chopper in the field to the bunk. The bunk is considered any structure used to store forages for fermentation. When filling the bunker, rapid filling and packing are important for uniform silage quality and to reduce the risk of exposure to precipitation and air during filling.
- **Oxygen limiting silos:** offer greater compaction and air restriction. It is recommended to blow dry ice inside the silo to prevent oxygen contact after filling and inject CO₂ periodically to further limit oxygen exposure.
- **Heap silage:** chopped forage is placed in a pile, typically used when first trying silage, preferably in a location that offers drainage to reduce spoilage. Depending on the size of the pile, packing to exclude oxygen may be done during or after piling.

Covering Silage

- A UV-resistant plastic cover or wrapping is recommended to exclude oxygen to ensure proper fermentation.
- Undesirable pH levels may occur if uncovered.
- Patch exposed holes with tape if there are any holes or tears in plastic covering.

Feeding Silage

Evaluating silage quality prior to feedout is a good strategy to ensure that the silage is properly fermented and of good quality. This can be done by visually inspecting and smelling the silage, as well as obtaining a representative feed sample and sending for laboratory analysis.

Properly fermented silage should smell subtly sweet and be light green, green-yellow or golden brown depending on the feed type ensiled. Dark brown silage with a tobacco or burnt odour may indicate heat damage and could reduce protein digestibility. If this occurs, send a sample to the lab for feed analysis and measure acid detergent fiber-bound nitrogen (ADF-N) to determine the amount of unavailable protein that is lost due to heating. Other odours indicative of poor fermentation includes rancid, fishy, mouldy, musty, overly sweet or ammonia and vinegar smells.

Table 2. Evaluation of silage quality

Characteristics	Good Quality	Intermediate Quality	Poorly Fermented	Overheated
Colour	Bright, light green yellow or greenish brown	Yellowish green to brownish green	Very dark green, blue green, grey or brown	Brown to black
Smell	Slightly sweet	Slightly sweet or ammonia	Rancid or ammonia	Burnt sugar or tobacco
Texture	Firm with softer material not easily rubbed from fibre	Softer material can be separated from fibre	Slimy, soft tissues easily rubbed from fibre, mouldy	Dry, easily broken down when rubbed, mouldy
Moisture Pit silage Oxygen limiting Silage bales	65% 50% 50%	Above 65% Above 60% Above 60%	Above 72% Above 70% Above 70%	Less than 55% Less than 40% Less than 40%
pH	4.2 - 4.8	4.9 - 5.2	Over 5.2	Not reliable

Adapted from Silage Manual by Government of Alberta

Typically, a mixer wagon is used to mix silage with other feed ingredients to make a total mixed ration. Silage may be fed from the pit using an electric wire or perimeter fence where cattle self-feed, which requires a 10-inch width of feeding space per head based on a maximum silage pit height of eight feet. Approximate feed intake from the face of the silage pit is approximately four inches in the winter and six inches in the summer for mature beef cattle when accounting for oxygen exposure and animal waste.

Protein Supplementation

Silage is typically higher in energy (TDN) compared to protein (CP), except in the case of cereal annuals and legumes. A protein supplement may be required to meet nutritional requirements.

Other Risks

Nitrates can be a concern if ensiling annual, warm-season, and brassica crops that are impacted by environmental stressors. Ensiling may reduce nitrate levels; however, it is recommended to feed test if nitrates are suspected to have accumulated in the crop. Management strategies can be used to dilute the nitrate content in the diet, such as blending other feeds to a safe level. If cutting an alternative crop, such as canola or kochia, it is recommended to take precautions as feed quality varies and antinutritional factors may be present.

Mycotoxins pose a risk to livestock, affecting both health and productivity. Potential symptoms include decreased feed intake, reduced poor performance and tissue damage. Reproductive issues may arise, such as increased incidence of abortions. Immunity can be comprised, leading to greater susceptibility to disease. In severe cases, mycotoxin exposure may result in fatality.

Other Resources

Feed Quality, Testing and Analysis for Beef Cattle - <https://www.beefresearch.ca/tools/feed-testing-analysis-for-beef-cattle/>

Feed Sampling and Analysis Information - <https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/livestock/pastures-grazing-hay-silage>

Feed Sampling Procedures - <https://www.youtube.com/watch?v=sfiadn3NMk8>

For more information on silage production, sampling, and feeding please contact the Agriculture Knowledge Centre at 1-866-457-2377 to connect with your regional livestock and feed extension specialist.