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Haylage and Other Fermented Forages

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Almost any legume, grass or pasture forage can be ensiled successfully

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Cutting fresh forage at the optimal stage of maturity and feeding it directly to animals year-round would supply the highest-quality and most palatable feed possible. In addition, field and storage losses would be the least of all methods of forage utilization. However, fluctuations in seasonal growth and plant maturity make it necessary to harvest and store forages to maximize both quality and productivity. Hay is the most widely used method of storing forages, but harvesting as grass or legume silage or haylage has several advantages over storing as hay, including:

1. Lower field losses when harvested as silage.
2. More nutrients preserved for feeding.
3. Lower labor costs because of more complete mechanization in harvesting and feeding.
4. Consistent forage quality on a daily basis when properly stored.
5. Greater ability to harvest the crop at ideal maturity, as less rain-free weather is needed for harvesting haylage.

Individual crops and mixtures used for making ensiled forage differ with climate, soil type and crop rotation in North Dakota. Almost any legume, grass or pasture forage can be ensiled successfully. Select the harvest time by the growth stage (maturity) of the predominant crop in the mixture.

Definitions

Forage silages can be separated into three groups on the basis of harvest moisture levels:

1. High moisture or **direct cut silage** at 70+ percent moisture.
2. **Wilted silage** at 60-70+ percent moisture.
3. **Low-moisture haylage** at 40 to 60 percent moisture.

Direct cut silage

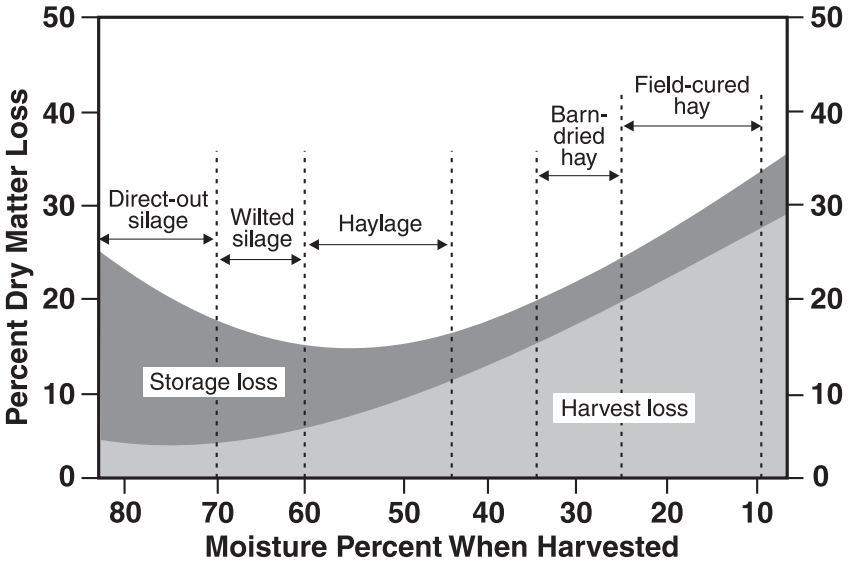
Freshly cut forage will normally contain 75 to 85 percent water. Ensiling direct-cut forages prevents weather damage and leaf shattering, and lowers harvest costs, but seepage loss from silages at this moisture

level can be high. The high moisture level in direct-cut silages can cause an abnormal low-temperature fermentation producing conditions favorable for undesirable clostridial organism growth. This produces silage that has an unpleasant sour, butyric-acid smell which severely reduces livestock consumption. Freezing during winter months is an additional concern as it causes excessive moisture in the silage making unloading more difficult.

Wilted silage

In making wilted silage, the forage is cut and left to wilt to reduce the moisture content. The number of hours of wilting required can vary depending on geographic location and weather conditions. Under ideal drying temperatures of late spring and early summer, four to six hours are usually adequate to reduce moisture levels to around 65 percent. Ideal moisture levels for storage in upright silos range from 62 to 65 percent and bunker silos from 65 to 72 percent. Seepage and runoff do not normally occur at these moisture levels and nutrient preservation is maximized.

The most common problem encountered in making wilted silage is that producers allow too much wilting to occur before ensiling. Wilted silage with drier-than-recommended moisture content will heat and have reduced digestibility as well as higher harvest and storage losses (Figure 2).



Adapted from: Hoglund, 1964

Figure 1. Estimated dry matter loss during harvest and storage of forge crops at various moisture levels.

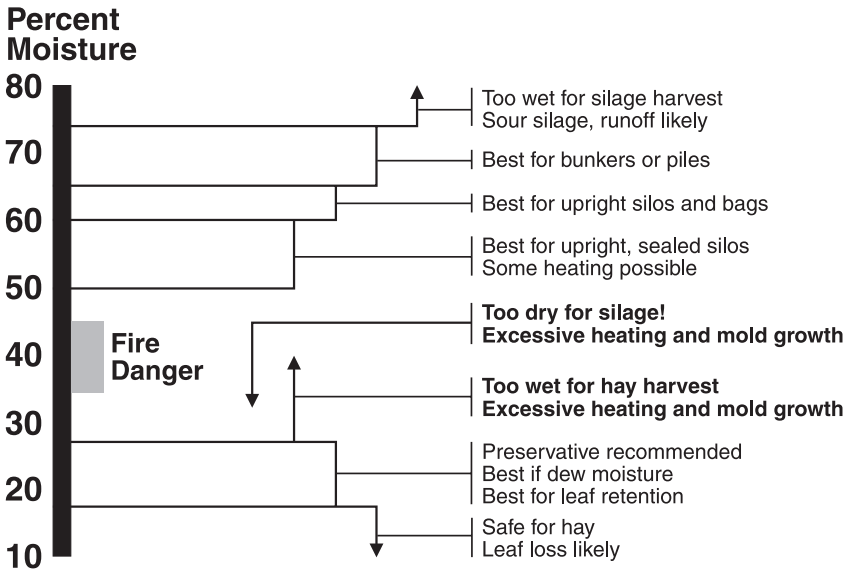


Figure 2. Moisture management guide for preserving forages as silage or hay.

Haylage

Making haylage out of harvested legumes and grasses is an alternate option for storing and processing forage. Haylage can be made from any crop that is traditionally stored as hay (Table 1).

Ensiling grasses and legumes as haylage requires 40 to 60 percent moisture. Reductions in moisture content necessary for production of haylage are accomplished by conditioning (mowing, windrowing and drying for four to 24 hours) and depends

Table 1. Crops commonly used for haylage in North Dakota and recommended stage of maturity for harvesting.

Crop	Stage of Maturity
Legumes	
• alfalfa	pre-bud to 1/10 bloom for first cutting 1/10 to ¼ bloom for second cutting ¼ to ½ bloom for third cutting
• sweet clover (and other clovers)	½ bloom
Perennial Grasses	
• cool season grasses	before grass heads emerge
– brome grass	boot to early head (May 15 to June 1)
– crested wheat	boot to early head (May 15 to June 1)
• wetland vegetation[1]	before heads emerge
Annual Grasses	
• sudangrass and sorghum (includes hybrids)	boot to early head
• millets	boot to early head
• small grains (oats, wheat, barley)	boot to early dough stage

[1] Wetland vegetation makes better forage stored as haylage than as baled hay at any stage of maturity.

on forage moisture and conditions. Considerably longer wilting is necessary to reduce moisture levels to 40 to 60 percent.

Haylage is the most sensitive of the ensiled forages to moisture variation. ***Just a few percentage points up or down can ruin your forage stored in this manner.*** Low-moisture haylage often becomes too dry for good harvesting and storage. Leaves, as well as some of the nutrient value, are lost in the dust created by the harvesting equipment. Whenever large clouds of dust come from the wagon being loaded, it is too dry for haylage and is better suited to hay.

In some cases, but less common than in years past, conventional upright silos are used for low-moisture haylage, but particular attention must be given to air exclusion. Fine chopping, rapid filling and good sealing of the forage from air are critical. Allowing air into the haylage will cause heating and the growth of undesirable yeast and molds.

In addition, haylage can heat spontaneously if oxygen becomes available. Fires have been reported when the moisture in the haylage is near 40 percent. More often, the heating will form indigestible products which lower protein and energy values. A haylage with tobacco-brown or black color and a caramalized odor has undergone some spontaneous heating.

Length of Cut

Large forage particles create difficulties in packing the silo as too much air will be trapped, causing conditions favorable for excessive heating and mold growth. Poorly chopped material with long stems is also difficult to handle mechanically, especially with silo unloading equipment and feed conveyors.

Forages can be chopped as fine as a quarter-inch if between 25 and 50 percent of the dry matter fed in the rations is from long baled hay. With an all-silage feeding program, theoretical length of cut (TLC) should be ⅜ inch, resulting in 15 to 20 percent of the particles being over 1.5 inches long. Chopping forages too fine decrease rumination, cud chewing, salivation and may cause rumen acidosis and low milk levels.

Feeding improperly fermented haylage can result in very adverse effects, including decline in milk production and an increase in dead or cull cows.

Stage of Maturity

Harvesting forages at the optimum stage of maturity is crucial for top animal performance and productivity. Wisconsin Forage Council data show that it takes only five to six days for alfalfa to mature from mid-bud to 1/10-bloom in the Midwestern states.

Delays in harvesting grasses after heads emerge or alfalfa after the 1/10-bloom stage decreases the quality of the forage. This is because the proportion of fibrous stems increases as the percentage of leaves decreases. Each day of delay in harvesting results in the crop dropping 0.5 percent in crude protein, while increasing 0.7 percent in ADF and 0.9 percent in NDF. Lignin, a potentially non-degradable fiber faction, doubles in quantity from 5 to 10 percent between early-bud and full-bloom stages. Not only is lignin not digestible, but it binds with other fiber components (cellulose and hemicellulose) as well as protein, making them non-digestible as well.

Studies have shown that for each day alfalfa matures past the late-bud stage, milk production can decrease by 0.86 pounds per cow

per day or up to 400 pounds per cow per lactation.

Pre-bud or bud-stage alfalfa leaves are high in protein and low in fiber, so the highest quality alfalfa can be obtained by harvesting when the leaf-to-stem ration is the highest. The various stages of alfalfa maturity are outlined in Table 2.

As forage matures, yield increases, but more plant fiber results in decreased digestibility. That means more grain must be fed to maintain high production levels, but with risk of compromising ruminal health. Cows normally eat forages at 2.5 percent of their body weight daily if fed hay harvested in the bud stage, but only about 1.5 percent of their weight if fed mature, full bloom alfalfa (Table 3).

Table 2. Stages of alfalfa maturity.

early bud	1 to 2 nodes with buds, no flowers
late bud	more than 3 nodes with buds, no flowers
early flower	1 node with 1 open flower
late flower	more than 2 nodes with open flowers

Adapted from Kalu & Fick.

Table 3. Effect of stage of maturity on digestibility of alfalfa.

Stage	Percent Digestibility
pre-bud	66.8
bud	65.0
early bloom	63.1
mid-bloom	61.3
full bloom	59.4
late bloom	57.5
mature	55.8

It is also important not to harvest plants too early. Immature plants, in the early-bud stage, have a high proportion of leaves and the stems have not become highly lignified, hard and unpalatable. However, by cutting alfalfa at the immature-bud stage for more than one year, carbohydrate root reserves may become depleted and plant vigor reduced. This effect is shown in Table 4.

Grass Silage

Grass as a silage crop is especially suited to areas of high rainfall where harvesting and storing of forages is made difficult because of reduced drying weather. The production of grass silage should employ the same general management practices discussed previously. Management attention should be focused on:

- cutting when the first stems begin to head out,
- wilting to less than 72 percent moisture,
- chopping at ¼ to ⅜ inch length, and
- packing the silage well to facilitate an anaerobic environment in the storage structure.

Grass silage is often harvested in wet environments not suitable for field wilting.

Ensiling direct-cut grass at high moisture levels (75 to 85 percent) presents management challenges. These high moisture ranges may allow an undesirable clostridial fermentation in the silage that produces a high level of sour-smelling butyric acid. Clostridia can also contribute to increased silage protein breakdown.

Another challenge with direct-cut grass silage is the additional lactic acid production required to lower the pH of extremely wet silage. This lactic acid is produced by bacteria feeding on plant sugars. Proper crop maturity at harvest and the presence of efficient fermenting bacteria will help reduce potential runoff problems.

If environmental conditions permit, the most ideal management practice is to wilt grass silage to approximately 65 to 72 percent moisture. This will provide an ensiling environment favorable for bacteria that can ensure proper fermentation.

Table 4. Effects of different alfalfa cutting frequencies on three-year yield, quality, weeds and stand life at the end of the third year.

	Harvest			% Dry Matter				
Maturity	Interval	Per Year	Yield	TDN	Protein	Leaves	Weeds	Stand
	(days)		(T/A)					(%)
Pre-bud	21	9-10	7.5	62.6	29.1	58	48	29
Mid-bud	25	8-9	8.8	60.2	25.2	56	54	38
10% bloom	29	7	9.9	58.2	21.3	53	8	45
50% bloom	33	6-7	11.4	57.8	18.0	50	0	56
100% bloom	37	5-6	11.6	55.7	16.9	47	0	50

Source: V.L. Marble, 1974. Fourth California Alfalfa Symposium.

Sorghum Silage

Sorghum is a popular silage crop in many arid areas of the United States. Sorghum adapts well to low rainfall areas and growing conditions not well suited for corn production. Sorghums vary widely in physical characteristics, but can be categorized into three main groups: forage sorghums, sorghum-sudangrass and grain sorghums.

Forage sorghum is the most common sorghum harvested for silage. It provides excellent tonnage and will generally have 80 to 90 percent of the feeding value of corn silage. Forage sorghum should be harvested when the grain is in the medium-to-hard dough stage or when it begins to lose color. The ideal moisture content should be 60 to 72 percent, depending on the type of storage structure to be used.

Sorghum typically dries slowly. Plant an early maturing hybrid if using a sealed structure and ensile at 50 to 60 percent moisture. Avoid ensiling in bunkers if moisture levels are above 75 percent. Excessive moisture may produce run-off and encourage the production of butyric acid which produces less palatable silage. The recommended chop length is ⅜ to ½ inch. However, if the crop becomes overly dry, chop finer and consider using a recutter screen.

Sorghum-sudangrass has typically been used as a summer pasture or hay crop. However, if ensiled properly, sorghum-sudangrass can make excellent quality silage. Total tonnage yield will be less than from forage sorghum, but if harvested early, it will contain one-and-one-half to two times the amount of protein, reducing the need for supplemental protein in the ration.

Sorghum-sudangrass should be harvested at the boot stage, at about three to four feet tall, just prior to head emergence. When ensiling at the recommended moisture of 60 to 72 percent, the crop will likely require field wilting.

Sorghum-sudangrass has fast regrowth and a second or third crop generally can be harvested if adequate moisture prevails. Be sure the plant is a minimum of 18 inches high before harvest to avoid possible prussic acid poisoning.

Grain sorghum has the highest grain-to-forage ratio of all sorghums and will have the greatest energy feeding value. Yield will be less since the plants are shorter. For optimum feeding value and efficient fermentation, harvest grain sorghum when the grain is in the medium to hard dough stage of maturity and moisture is 60 to 68 percent. Harvesting once the grain is fully developed will result in lower feed value because much of the grain will pass through the animal undigested.

Sorghum adapts well to low rainfall areas and growing conditions not well suited for corn production

Sweetclover Silage

Sweetclover is sometimes stored as silage in North Dakota. It should be harvested for silage at the 10 to 20 percent bloom growth stage. Sweetclover harvested at this growth stage will have about the same feed value as alfalfa.

Sweetclover, like alfalfa, is low in sugar content and requires field wilting to concentrate the sugars in the cell sap. The crop, when harvested at the 10 to 20 percent bloom growth stage, contains about 80 percent moisture. The crop should be wilted to an average of about 65 percent moisture when placed in the silo as high moisture silage. If stored as haylage in oxygen-limiting silos, the moisture content should be between 55 to 60 percent.

Sweetclover contains a compound called coumarin. The coumarin is converted to a toxic substance in molded or spoiled silage and may cause "sweetclover bleeding disease." The toxic substance (dicoumarol) reduces the clotting power of the blood of animals. Animals consuming too much dicoumarol over time may bleed to death from slight wounds or internal hemorrhages. If animals are to be dehorned or castrated, do not feed sweetclover forage for at least three weeks prior to working cattle and at least 30 days prior to calving.

Molded or spoiled sweetclover silage can be very dangerous when fed as the only forage if high dicoumarol levels are present. Preventing mold formation in sweetclover silage is very important if high coumarin content varieties are grown.

Choose a low coumarin variety of sweetclover that can be grown to eliminate the potential danger of "sweetclover bleeding disease." Always purchase certified seed or the benefits of growing a low coumarin variety will be lost. This is because low coumarin varieties may revert back to a high coumarin level if more than three generations away from breeders' seed.

Follow good silage management practices. Fill the silo rapidly, harvest at the proper moisture content, pack to exclude air from the silage mass, distribute the chopped forage uniformly in the silo when filling and cover to exclude outside air from entering the silage. Another alternative is to place a layer of another forage type over the sweetclover silage to reduce the potential for molding of sweetclover, then cover the silo.

Small Grain Silage

Silage is an excellent way to utilize small grain crops used in companion cropping programs or grown to supplement forage supplies. Harvesting cereals as silage can also salvage a crop that has been damaged by hail, frost or insects.

Cereal silages should be harvested in the milk to soft dough stage to maximize the yield of energy per acre. As cereal grains mature from the boot to the dough stage, the protein level drops while the energy value increases. Dairy producers can maximize protein content by harvesting cereals in the boot stage. Little wilting is necessary when harvesting at the early dough stage.

Approximate feeding values for commonly grown cereal crops for North Dakota are found in Table 5.

Moisture levels between the range of 60 to 70 percent are best for ensiling cereal-grain silage, with 65 percent being the optimum. Small grain silages with less than 60 percent moisture are difficult to pack. These crops dry quickly once cut and care should be taken to chop only at the recommended moisture content.

Baleage

Baleage, also known as round bale silage, is a somewhat newer method of preserving forage. Baleage is simply forage that is baled at a higher moisture content than dry hay and then stored in sealed plastic wrap. Because of the high moisture level and air-tight environment, the forage ferments and is preserved by acid production during fermentation. This method has certain advantages and disadvantages over other forage harvesting and preservation systems.

Advantages of Baleage

1. Decreased curing time needed from cutting to baling makes weather less of a factor in forage harvesting.
2. Potential for more timely harvest of large quantities of forage.
3. Decreased need for mechanical handling and time curing to dry the forage reduces the loss of leaves, the most digestible part of the plant.
4. Potential for higher feed quality bale through leaf preservation and possible nitrate reduction.

Disadvantages

1. Increased harvest cost per bale versus conventional cured hay.
2. Disposal of used plastic wrap.
3. More likely to spoil as compared to silage in traditional silos.
4. Risk of forage spoilage if integrity of wrap is not maintained. Birds and rodents can puncture plastic and holes must be covered.
5. Transportation of bales is limited due to cost of moving high-moisture bales.

Table 5. Feeding values of small grain and corn silage.

Silage	Dry Matter	Crude Fiber	Crude Protein	TDN
		percent dry matter		
barley	38.8	27.1	9.0	64.3
wheat	39.4	27.9	9.6	63.8
oats	40.2	31.2	9.8	60.7
rye (wilted)	39.8	33.0	12.8	58.5
corn	37.3	24.7	8.1	66.4

Source: Virginia Polytechnic Institute and State University

Making Baleage

The forage is cut as if for making hay, but is baled at 50 to 60 percent moisture rather than at 18 to 20 percent moisture. Baling at the proper moisture content is the single most important variable. Baling haylage with too much moisture reduces the feed quality of the forage and reduces the amount of dry matter stored per bag, greatly increasing storage cost. Baling haylage with inadequate moisture reduces fermentation and increases mold production, greatly increasing storage losses.

Storage

Successful storage depends on many factors. The storage site should be cleared of stubble and sharp objects. Some people lay a piece of plastic on the ground prior to placing the bales. Rodents can chew through the plastic wrap or bag which will greatly increase storage losses. Spray the perimeter of the stack to kill weeds which harbor rodents and insects. Find a shady area, preferably on a north facing slope, to avoid temperature fluctuations which can degrade both the haylage and the plastic.

If you find holes in the bagged bales, patch them as soon as possible, because wind causes loose plastic to bellow out, providing an air exchange which usually spoils most of the outer layer of the bale. Bags are rarely reusable because of minor pinholes.

Ensiling forage as baleage can be a management strategy for high-nitrate grass. Scientific literature suggests an average of 50 percent reduction in nitrate in ensiled forages due to the de-nitrification process.

Feeding Baleage

Feeding baleage is similar to feeding large round bales of hay, in that conventional feeding rings can be used. With the high investment in wrapping bales, it is essential to control feeding losses. Some studies have shown up to a 50 percent loss when large round silage bales are fed to cattle without being placed in a ring feeder. This loss can be reduced to 10 to 20 percent by using a simple ring feeder. The use of an elevated hay wagon can reduce feeding losses to below 10 percent.

When feeding individually wrapped haylage bales to any species, it is best to feed to a sufficient number of animals to eat an entire bale within one or two days. If multiple bales are ensiled in a plastic tube, the tube may be opened to remove individual bales and resealed without significant spoilage for up to two weeks.

Other publications in the Quality Forage series

- AS-1250 Forage Nutrition for Ruminants
- AS-1251 Intrepreting Composition and Determining Market Value
- AS-1253 Corn Silage Management
- AS-1254 Silage Fermentation and Preservation
- AS-1255 Storage, Sampling and Measuring
- AS-1256 Stressed-Damaged Crops

References

In addition to sources cited, materials were adapted with permission from Pioneer Forage Manual, no longer in print.

For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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