Using Silos and Silage

OSU EXTENSION FACTS

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Desire to automate the feeding program, labor problems, and costs of harvesting and hauling hay have caused many dairy and beef producers to consider the change from hay to a silage program. The possibility of high nutrient yield per acre from silage along with complete mechanical handling of the crop from the field to the feed bunk makes silage an attractive source of forage. There are many factors to consider when evaluating a silage system for a dairy or beef operation. Principal factors are: size of herd at present; size herd may be expanded to in the future; length of time operator plans to be in business; available labor; existing facilities; available capital, costs of capital and cost of proposed silage facilities.

Advantages of Silage

Silage offers a number of advantages:

(1) With silage and all of the necessary equipment, it becomes possible to completely automate the feeding program from the crop standing in the field to the silage in the feed bunk; (2) Corn or sorghum silage will yield more TDN (total digestible nutrients) per acre than most other crops; (3) Either row or broadcast crops can be made into silage; (4) The decision can be made during the growing season whether to go into the silo or harvest a crop as grain. This provides greater flexibility in harvesting crops for livestock feed; (5) Corn or sorghum silage can be harvested over a wider range of time than crops intended for hay without sacrificing as much quality; (6) Weather isn't as critical in harvesting silage crops as in the case with harvesting hay or grain; and, (7) Silage makes a good palatable feed for cattle and provides a good place to add grain to the ration by topdressing the silage.

Disadvantages of Silage

These are some problems with silage which must be recognized also:

(1) Silage losses can be high if crops are not harvested at the proper moisture content and if storage facilities are inadequate; (2) Silage is bulky to store and handle, which can cause storage costs to be high in relation to the value of the product; (3) Silage storage facilities have limited alternative use; (4) Silage is costly to transport and should be grown within a relatively short distance of the silo; and (5) When the decision is made to invest in equipment to harvest, store and feed silage, the commitment should be for a period of ten years or longer.

Size and Capacity of Silos

When a silage system is being considered, one of the early decisions is the size of silo or silos needed. The amount of silage needed varies with the size of herd and type of forage feeding program planned. Table 1 provides an estimate of the annual silage needs per animal when silage is the primary forage to be fed.

Table 1. Estimated Annual Silage Needs

Maturity of Animal	*Corn or Sorghum (65 to 70% Moisture)*	*Haylage (45 to 55% Moisture)*
	(tons)	(tons)
Dairy cow	7 - 10	4 - 6
Yearling dairy heifer	2 - 3	1 - 2
Yearling steer	2 - 3	1 - 2
Beef cow	3 - 5	2 - 4

Tables 2, 3, and 4 provide an estimate of the storage capacity of horizontal and upright silos. The actual amount of silage stored may vary depending upon moisture content, fineness of chop, distribution and packing. The key point in silage storage is the actual amount of dry matter contained in the silo. For example: in table 3 a 60 x 20 upright silo holds approximately 478 tons of 70% moisture silage while

Table 2. Estimated Capacity for Corn or Sorghum Silage At 65-70% Moisture of Trench or Bunker Silo*

Size	*Settled Capacity*	*Feedable** Silage*
(feet)	(tons)	(tons)
12 x 30 x 110	781	664
12 x 40 x 120	1,116	949
14 x 40 x 140	1,526	1,297
14 x 40 x 160	1,744	1,482
14 x 40 x 180	1,962	1,667
16 x 40 x 220	2,398	2,038

*Sides of silo sloped outward 1½ inches for each foot of depth.
**Feedable silage is the amount of silage stored less silage lost due to spoilage. A 15% loss of nutrients was used to estimate feedable silage.

Table 3. Estimated Capacity In Tons of Corn or Sorghum Silage At 65-70 % Moisture of Upright Concrete Stave Silo

Size	*Settled Capacity*	*Feedable* Silage*
(feet)	(tons)	(tons)
20 x 60	478	444
22 x 60	579	538
24 x 60	689	640
30 x 60	1,076	1,000
30 x 70	1,332	1,238
30 x 80	1,600	1,488

*Feedable silage is the amount of silage stored less silage lost due to spoilage. A 7% loss of nutrients was used to estimate feedable silage.

Table 4. Estimated Capacity In Tons of Haylage At 50-55 % Moisture of Gastight Silo

Size	*Settled Capacity*	*Feedable* Silage*
(feet)	(tons)	(tons)
20 x 60	286	265
22 x 60	345	327
24 x 60	410	389
30 x 60	643	610
30 x 70	794	754
30 x 80	960	912

*Feedable silage is the amount of silage stored less silage lost due to spoilage. A 5% loss of nutrients was used to estimate feedable silage.

in Table 4 a 60 x 20 upright silo holds 286 tons of 50% moisture silage. On a dry matter basis each of these silos contain 143 tons.

Silage losses vary with the type of silo and the management of the silage program. Losses occur from seepage, surface spoilage and fermentation. Proper management is essential to obtain maximum preservation of nutrients regardless of the type of silo. Based on experiments by the USDA at Beltsville, Maryland and various University Experiment Stations across the United States, the range in storage losses of silage is quite wide for each type of silo. The percentage of loss used to determine feedable silage in these tables was based on an average of the range of losses reported in the studies referred to above.

Types of Silos

Tower silos are usually classified as conventional silos. These include concrete stave silos and the various types of gastight silos. The gastight silos include those which, by various means, exclude oxygen from the silage and, thereby, curtail losses due to spoilage. Horizontal silos are classed as trench silos below ground and bunkers above ground.

An upright concrete stave silo with tight walls and doors which have been sealed with plastic or by other means, will be reasonably airtight except at the surface of the silage. After the silo has been filled the silage surface can be sealed with plastic which will keep storage losses to a minimum. When the silo is opened and feeding begins, removal of a uniform layer 2 to 3 inches in depth daily will help keep spoilage to a minimum.

Gas-tight structures have a higher initial cost but have lower storage losses than other silage structures. Gas-tight silos with bottom unloaders provide greater flexibility in the feeding program. These silos can be refilled without interrupting the daily feeding process. The more times the silo can be filled annually the less will be the investment cost per ton of silage.

There are a variety of top unloaders which vary in design and capacity. The average capacity for these unloaders is approximately one ton per hour for each horsepower rating of the motor. Grass silage packs tighter and unloads slower than corn or sorghum silage. Some manufacturers have developed silo unloaders with greater capacity within recent years. The speed of unloading may not necessarily be a major point of consideration where a completely automated feeding operation from the silo to the feed bunk is used.

Horizontal silos have the lowest investment cost per ton of silage but also have the greatest losses due to spoilage. The regular trench silo which has been used for so many years may simply consist of a trench in the side of a hill with dirt walls and dirt floor. Spoilage in these structures can be very great. The use of concrete for flooring and walls cuts the spoilage losses tremendously, lengthens the life of the silo and facilitates unloading. Good drainage should be a primary consideration in selecting a site for a trench silo.

Bunker or above ground silos, with concrete floor and walls have gained in popularity in recent years. In smaller herds this type of silo may be used for self-feeding, using an adjustable gate or other means. However, in larger herds the silage is removed from the silo and fed in bunks. A front-end tractor loader or a horizontal silo loader which is mounted on an old tractor or truck are the two more common loaders used in horizontal silos. The latter moves up and down the surface of the silage shaving the silage loose, leaving a smooth surface. Regardless of the method used a uniform amount of silage should be removed daily to keep spoilage to a minimum.

The greatest loss in horizontal silos is from top spoilage. This is due to the amount of surface area exposed. Excess oxygen at the surface results in undesirable fermentation and molding. This loss can be reduced by covering the top surface of the silage immediately after filling to seal out as much air as possible and to keep water from penetrating the silage surface. Black polyethylene plastic is commonly used to cover most silo surfaces. The plastic must be thick enough to prevent damage by wind. All edges must be sealed to exclude air and water.

Filling and packing the horizontal silo requires more time and effort than does the upright silo. A tractor with a scraper blade is commonly used to level and pack each load of silage as it is unloaded. Continuous and thorough packing is necessary in the trench and bunker silo to reduce fermentation losses. When the silo is filled the center should be crowned with two to three feet of silage to facilitate water drainage.

Investment Costs

Investment costs for silos vary according to size and type of construction. A good way to compare silos is by the investment per ton of feedable silage. For upright silos, these estimates include the cost of the foundation, the silo, roof and erection of the structure. For horizontal silos (trench and bunker) the estimates include the cost of materials and construction. If complete automation of feeding is planned, then the cost of all mechanical feeding equipment must be included.

Studies show that investment cost per ton of feedable silage is lowest for horizontal silos and highest for gastight silos. The trench or bunker averages about one-third the cost of a gastight silo, while the concrete stave is about two-thirds the cost of the gastight silo. These investment-per-ton studies are based on a single filling and can be reduced by filling the silo more than once during the year. Many livestock farming operations depend upon year around use of the silo which generally means having crops available for spring and fall fillings.

Crops for Silage

Most crops grown for livestock feed can be stored and preserved as silage. This includes crops which are ordinarily made into hay, such as alfalfa, sudan, oats wheat, millet, and others.

Unlike the hay crops that are cut and wilted to decrease the moisture content, corn and sorghum silages are cut direct and usually contain 65 to 70% moisture. The only means of reducing moisture in these crops is to permit them to stand in the field and become more mature. There has to be some compromise between moisture content and total feed energy. If the plant is cut too early, the moisture content will be too high and some potential yield of dry matter will be lost. If it is cut too late, maximum TDN will not be obtained.

Grain and forage sorghum crops generally offer a better opportunity than corn for making silage in most sections of Oklahoma due to limited rainfall. Silage yields of forage sorghums may equal corn, but the nutritive value will be somewhat lower, and total feed energy per acre is usually less.

Hay Crop Silage

Hay crop silage refers to silage made by ensiling any type of plant which is ordinarily thought of as a hay crop plant. Alfalfa, small grains, sudan grasses, millet and clovers, or certain combinations of these plants, are the most common crops made into hay crop silage.

Haylage, low-moisture silage, and grass silage are terms which have been coined in referring to hay-crop silage and are probably more familiar terms than any other to most producers.

Hay-crop silage has a number of advantages over other means of storing forages:

(1) More dry matter can be preserved and stored than by other means; (2) Crops can be harvested earlier at a more nutritious stage of growth; (3) More of the protein in home grown forage may be preserved; (4) High quality forage, which could be a problem to get into the bale due to weather, can be put into the silo; and, (5) Excess supplemental pasture growth may be put into the silo.

Individual crops and mixtures of crops used for making silage differ with climate, soil type, and crop rotation. Most crops which can be successfully made into hay can also be ensiled. The best stage of growth for harvesting hay-crop silage is generally at the same stage as the crop should be cut to make good hay. Delays in harvesting beyond the pre-heading stage in grasses or first-bloom stage in alfalfa decrease palatability and digestibility of the forage. Research shows that each day's delay may decrease digestibility approximately one-half percent.

When wilting hay crops for silage to be stored in concrete stave or horizontal silos the moisture content should be reduced to 70% or less before the first load is put in the silo. In the case of alfalfa, it is a good procedure to begin filling the silo when the moisture content reaches 70% to allow a safe moisture range. Later loads will be drier so that the ensiled material will average about 60%. Forage stored in the upper portion of the silo may contain 65 to 70% moisture. The wetter forage will help form a top seal to prevent air from entering the silage surface and the weight will help expel oxygen from the forage stored below.

Gastight silos are especially suited for storing hay-crop silage. Air cannot reach forage stored in these structures to cause molding. The moisture content of the wilted crop may be reduced to 50% or less for storage in these structures.

Upright concrete stave silos are used satisfactorily to store hay-crop silage. Inside walls and doors should be free from cracks and holes to prevent air from getting to the silage. Doors may be lined with plastic sheeting to help seal them. The silo must have adequate reinforcement to withstand high pressures associated with this type of silage. Good drainage at the bottom of the silo is necessary to prevent saturation in the lower portion of the silo. It is also a good procedure to prepare some kind of seal at the top of the silage after filling to prevent spoilage.

Trench and bunker silos are less expensive but require greater skill in filling and sealing because of the larger amount of forage exposed to the air. Rapid filling, good packing, and covering to omit air immediately after filling is necessary to maintain good quality hay-crop silage in this type of silo.

Nutritive Value of Silage

Processing feed through a silo will not make low quality feeds into high quality feeds. The digestible nutrient content of silage depends primarily on the nutritive content of the original crop. However, the harvesting procedure as well as the ensiling process and storage can affect the preservation of nutrients contained in the crop. The actual feeding value of silage depends on its digestible nutrient content and its acceptability by the animal.

Harvesting a crop at the optimum stage of maturity to obtain the highest percentage of digestible dry matter is perhaps the most important step in making nutritious silage. The harvesting operation should establish good conditions for proper ensiling of the crop. Two important considerations here are to:

(1) Establish proper moisture content; and, (2) Adjust the length of cut. These two factors improve compaction and insure the desired fermentation for better preservation of nutrients in the silo. Excessive moisture in silage can result in loss of nutrients through improper fermentation.

Comparative nutritive values for several silage crops are shown in Table 5. The values in this table are a compilation of average estimates from various research sources. In the absence of a forage analysis on a specific silage the values in this table can be used as a guideline for estimating feeding value. A forage analysis on silage can be valuable when the information obtained is used to prepare a feeding program based on the analysis.

Silage Additives

Some crops are direct-cut and placed in the silo at 75 to 85% moisture. Dry grain may be added to direct-cut silage at a rate of 200-400 pounds per ton. The dry grain will absorb much of the excess moisture from the silage and reduce the moisture content to a satisfactory level. The grain also provides a source of carbohydrates from which the acids are produced to bring about proper ensiling of the hay-crop forage. Although grain increases the feeding value of the silage, 15 to 20% of the feeding value of the added grain may be lost during the fermentation process. Molasses is sometimes used as an additive at the rate of 60 to 100 pounds per ton of fresh forage. This increases the percent of fermentable carbohydrates and generally produces a silage of good quality. If water has to be added to dilute the molasses so that it will flow more freely, this increases the moisture content of the silage and may increase seepage losses.

There are numerous preservative materials available to mix with direct-cut silage or wilted silage. These products generally produce desirable fermentation, but add little or nothing directly to the feeding value of the silage as in the case of grain. Additives should serve one or more of the following purposes in order to be effective:

(1) provide fermentable carbohydrates; (2) furnish additional acids directly to increase acid conditions; (3) specifically inhibit undesirable types of bacteria; (4) directly or indirectly reduce the amount of oxygen present; (5) reduce the moisture content of the silage; (6) absorb some acids which might otherwise be lost in seepage.

Silage, like any other forage, must be managed properly through harvesting, storing, and feeding in order to make a forage that will produce a satisfactory flow of milk in dairy cattle or gain in beef cattle.

Table 5. Approximate Nutritive Value of Various Silages

		TDN		Net Energy		As Fed Basis			
	Dry Matter*	DM Basis	As Fed	DM Basis	As Fed	Protein	Fiber	Ca.	P.
	(%)	(%)	(%)	Mcal/cwt	Mcal/cwt	(%)	(%)	(%)	(%)
Alfalfa silage (early bloom)	40	57	23	55	22	7.4	10.0	.41	.07
Alfalfa silage (mid bloom)	40	55	22	53	21	6.4	11.0	.42	.06
Corn silage	35	70	25	64	22	3.2	7.0	.09	.06
Forage sorghum	35	56	20	55	19	3.0	11.0	.10	.08
Grain sorghum	35	57	20	56	19	2.8	8.0	.08	.06
Sorghum-sudan hybrids	35	56	19	54	19	3.1	11.0	.11	.09
Sudan grass	35	55	19	53	18	3.8	11.0	.21	.07
Oat silage	35	58	20	56	19	3.2	10.0	.12	.10

*The dry matter values used in this table were selected as being representative of crops commonly ensiled in Oklahoma. The percentage of dry matter affects the nutritive values in each of the "as fed" columns. Crops stored in gas-tight silos are commonly ensiled with higher levels of dry matter than shown in this table.

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