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Chapter 8

SILAGES AND HAYLAGES

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CHAPTER 8

SILAGES AND HAYLAGES

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Silage results from the storage and fermentation of fresh forage under oxygen-free conditions. Bacteria which grow under these conditions ferment available carbohydrates to organic acids which cause the ensiled forage to become slightly sour. The acids eventually kill the bacteria and preserve the silage in a palatable state as long as air is excluded.

The oxygen-free conditions are achieved either by the use of an "oxygen-limiting" silo, which is designed to be sealed when forage is not being added or removed, or by packing the mass of chopped forage thoroughly so that air can penetrate only a few inches inward from the surface. Within the first few days after ensiling, there is considerable heating and formation of carbon dioxide. Both are necessary to create an environment in which the acid-forming bacteria can grow. If the plants ensiled contain readily available carbohydrates, i. e., sugar and starch, lactic acid and a lesser amount of acetic acid are formed in sufficient quantities to preserve the forage. However, if the plants contain an inadequate amount of available carbohydrates, lactic and acetic acid levels do not become high enough to prevent the growth of undesirable bacteria, such as those forming butyric acid, resulting in decomposition and a foul-smelling silage. Suitability of various crops for silage will be discussed later.

Desirable fermentation may occur at moisture conditions ranging from 30 to 70 percent, but if the air is to be excluded by packing, a minimum water content of

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60 percent for chopped forage or 55 percent for "recut" forage is essential. Forage that is between 30 and 50 percent moisture is called "haylage" and must be ensiled in oxygen-limiting structures. Edible silage can be made with forage carrying above 70 percent water, but palatability declines as moisture increases above that level. The use of wilting or of certain additives as a partial solution to this problem will be discussed later.

Water is added only when necessary to bring the moisture up to 30 percent for haylage or to 60 percent for silage. Water should never be added to silage which contains sufficient moisture to pack well. Excessive water will cause seepage and loss of nutrients in the soluble constituents.

From a harvesting standpoint haylage requires one additional operation--wilting. After cutting, the forage must be laid down to wilt for a period of time. It must, therefore, be picked up again with a field forage chopper equipped with a windrow attachment. The modern wide-cutting machines which mow, crimp, and windrow the forage crop in one operation are ideal for preparing the forage for the chopper, which tows a self-unloading wagon to gather and haul the chopped forage to storage structures.

To a lesser degree wilting is used for lowering the moisture content of grasses and legumes that are to be made into silage. Under good drying conditions 4-6 hours of exposure to sun in the swath will bring the moisture to between 60 and 70 percent.

Numerous additives have been used over the years in the making of silage, particularly with unwilted high-moisture hay crops which normally contain inadequate quantities of readily available carbohydrates. The need for additives is also encountered when immature, high-moisture sorghums are harvested for silage by the direct-cut method. The use of molasses, dry grain, formic acid, limestone, and other available additives have proved beneficial with this type of crop.

Most research indicates less beneficial results from the use of additives when the forage has been wilted to below 70 percent moisture than with the direct-cut, high-moisture crop. In the Southwest where considerable use is made of the bunker and trench type silos, the application of additives is made difficult by the fact that the silage is frequently hauled to the silo in dump trucks and spread with a tractor

or bulldozer. This makes an even distribution of the additive through the material very unlikely.

When the silage is blown into an upright silo, the problem of metering an additive into the silage at the blower is fairly simple. Recommended quantities of additives to be used are 10 pounds of limestone, 30 pounds of molasses, 100 pounds of ground grain, or 10 pounds of formic acid per ton of green forage. The molasses and grain add nutrients to the silage and improve the feeding value as well as the palatability. The formic acid may or may not increase the availability of nutrients in the silage, but does increase the acidity and results in a more palatable silage. Some researchers (Waldo et al., 1971: Derbyshire and Gordon, 1969) have shown slight improvements in digestibility and efficiency of utilization for the formic acid-treated silage.

The addition of 0.5 to 1.0 percent limestone at ensiling has proved somewhat beneficial to fermentation. The most significant effect is the improvement in production of total and individual organic acids, with lactic acid being most affected. Adding more than 0.5 percent limestone reduces total acidity, thereby increasing the pH of the silage as the level of limestone increases; however, it is generally recommended that pH not be above 4.5 for the most desirable silage, and that the limestone added not exceed 1 percent. In feeding research, treating the silage with 0.5 to 1.0 percent limestone had no effect on rate of gain of cattle, but feed efficiency was generally improved (Essig, 1968). Digestibility of whole plant or ground ear corn silages by lambs was not altered by the addition of limestone.

The addition of urea at the rate of 10-15 pounds per ton will not improve the quality of the silage in terms of palatability but will increase its protein content for ruminant animals. In fact some lowering in the palatability and dry matter intake of corn or sorghum silage-treated with urea can be expected. The addition of urea to grass or legume silage is not recommended.

When both urea and limestone are added to corn forage at ensiling time, they appear to have the same influence as when each is added separately. It has been recommended that 0.5 percent urea and 0.5 percent limestone be added to corn forage to increase its crude protein and calcium content. If sweet sorghum forage is the available material, levels of 0.75 percent urea and 0.5 percent limestone have been suggested to give the desired crude protein content. There appears to be no difference in daily gain of cattle fed urea-treated silage compared to those fed untreated silage with adequate protein supplements.

PRODUCTION PRACTICES

Crops Suited to Silage and Haylage

Almost any crop used for grazing or hay can be used for silage, including perennial grasses, legumes, winter cereals, ryegrass, alfalfa, sudangrass and sorghum x sudangrass hybrids, and millets. However, most of the silage is made from crops planted and grown specifically for silage production, especially forage sorghums and corn.

The surplus growth that develops in the spring on winter cereals and ryegrass used for grazing is easier made into silage than into hay because of the poor drying conditions for hay at that time of year. Forage produced at this season may be extremely high in moisture, necessitating wilting before ensiling (see Introduction). Perennial grass growth may be allowed to accumulate to be used for silage at any time during the growing season.

Corn is considered the ideal or optimum for silage in many areas because of its high yield, favorable moisture content at harvest, and high grain:stalk ratio. The latter provides a high level of fermentable carbohydrates which in turn give good forage preservation and high quality silage. However, under many conditions in Texas, corn yield may not be competitive with forage sorghums, especially in total dry matter production. In work at six locations in East and Central Texas in 1956 and 1957 prior to the advent of hybrid sorghums, Atlas and Honey produced 26 percent and 73 percent more forage, respectively, than Texas 34 corn (Quinby and Marion, 1960). The plant populations of corn may not have been sufficiently high for maximum forage production. However, later work indicates only limited response to dense populations. Sorghum hybrids are now available that produce higher tonnages, but little further improvement has been made in total dry matter production of corn. Under irrigation in the Brazos River Bottom near College Station, corn has produced more than 26 tons

per acre of 70 percent moisture silage (Table 8-1).

Table 8-1. Forage yield and plant characteristics of four irrigated crops grown for silage, Texas A&M University Farm near College Station, 1967.

Row spacing (inches)	Lb. seed/acre[1]	Corn	Medium maturing forage sorghum	Late maturing forage sorghum	Grain sorghum
		Tons of 70 percent moisture silage			
20	4	20.7	37.0	50.3	17.0
	8	24.3	40.0	48.7	20.0
	12	26.3	39.0	36.3	22.3
40	4	28.3	34.0	43.7	14.7
	8	28.0	45.7	46.0	18.7
	12	28.3	30.7	45.3	18.7
		Percent stalks and leaves			
20	4	71	91	95	67
	8	73	93	97	69
	12	73	93	98	73
40	4	51	88	95	62
	8	58	90	96	69
	12	60	87	95	68
		Percent ears or heads			
20	4	29	9	5	33
	8	27	7	3	31
	12	27	7	2	27
40	4	49	12	5	38
	8	42	10	4	31
	12	40	13	5	32

[1]Corn populations were 16, 24, and 32 thousand plants/acre.

Forage sorghums are the most widely used crops for silage in Texas. Forage yields may be quite high, and the grain content may vary from nil to almost 40 percent, depending on the variety or hybrid being grown and stage of maturity at harvest.

Hybrid forage sorghums were introduced in the late 1950's, and a wide range of types is available. Both the varieties and hybrids may differ in plant height, stalk size, grain production, and length of time required to reach a given maturity. In general, total dry matter production is influenced by length of growing season with the later maturing types being higher producing. The hybrids within a maturity class are likely to be higher producing than the open-pollinated varieties. Thus, hybrids have essentially replaced varieties, and it is difficult to find seed of varieties such as Honey, Tracy, Sart, Atlas, Sumac (Red Top), Leoti, and others. In general, grain production is as high or higher on the earlier and lower producing types as on the late types and thus the grain:stalk ratio is higher on early types. It is possible to have almost no grain production on some of the late-maturing types which may head very poorly or not at all under some conditions. Yields of 70 percent moisture silage in excess of 20 tons per acre are readily obtained with the robust, long-season hybrids.

Grain sorghum hybrids are often used for silage, particularly where high digestible energy content is desired. Total dry matter production of the grain types is less than that of forage types and may be less than that of corn. In an irrigated study near College Station 70 percent moisture silage yields of corn, grain sorghum, and medium- and late-maturing forage sorghums were 26.9, 19.5, 38.2, and 45.9 tons per acre, respectively. The unthreshed head may represent as much as 40 percent of the entire harvested plant, and this percentage can be increased further by increasing the height of cutting. Grain sorghum forage cut when the grain is in the medium dough stage contains about 70 percent moisture. Fermentable carbohydrate content is favorable for the production of palatable, high quality silage.

Coastal bermudagrass is grown extensively and used primarily for hay and grazing but is suitable for silage. The primary disadvantages are relatively low yield per cutting and relatively low fermentable carbohydrate level, especially if the forage is nearly mature. A yield of 1 1/2 to 2 tons of dry matter (hay) per cutting may be obtained, which prior to drying contains 60 to 65 percent moisture. Thus yields of 4 to 5 tons of silage per acre per cutting might be expected under good production conditions. Total production for the growing season might exceed that of the best sorghum hybrids, but several harvests are required versus a single harvest of sorghum or corn.

Dallisgrass is grown extensively in the Coastal Prairie and may be used for silage. Spring growth especially is rapid and may exceed that required for grazing if stocking rates are based on summer production levels. Spring is an unfavorable season for

making hay in the Coastal Prairie, so silage provides an alternative. The moisture content of dallisgrass forage which has been allowed to accumulate should not be excessive for ensiling.

Cultural Practices for Sorghum and Corn

Sorghum and corn are traditionally planted in rows for silage. However, numerous innovations have been introduced in recent years including double rows on normal width beds, narrow rows, drill, and broadcast. Harvesting equipment is available or can be adapted for harvesting other than row plantings. Seeding rates, too, have varied widely within each method of planting.

In studies conducted in 1953 and 1954 with early maturing sorghum varieties, Holt and Smith (1956) reported that neither seeding rates nor seeding method influenced yield (Table 8-2). Stem diameter decreases with increased seeding rates. Plant

Table 8-2. Influence of seeding method and rate on forage yield and quality of early maturing sorghums at Prairie View, 1953-54.

Seed, lb./acre	1953-54[1] Green weight, tons	1953-54[1] Dry weight, tons	Stalk Diameter mm	Stalk Height inches	Percent of total forage Leaves	Percent of total forage Stalks	Percent of total forage Heads
			Broadcast				
40	12.7	3.0	7.6	57	25	46	29
60	13.2	3.6	6.7	54	25	51	24
80	13.4	3.6	6.4	56	31	49	20
100	13.9	3.8	6.2	58	29	52	19
			40-inch row				
7	13.2	4.0	12.9	71	36	42	22
14	12.4	3.8	11.3	70	23	42	35
21	13.5	3.7	11.3	72	22	46	32
28	12.1	3.6	9.0	69	22	45	33

[1] Sumac was used in 1953 and regular Hegari in 1954. Treatments did not significantly influence yield in either year. (Holt and Smith, 1956).

height is likely to be greater in rows than in close-drill or broadcast stands. Similarly, percentage of the total dry matter represented by the grain or head is greater in rows than in close-drilled plantings and is likely to decrease with increased seeding rates, particularly in close-drill.

Similar seeding rate results have been reported for medium- and late-maturing varieties (Table 8-3) Holt and Smith, 1956). Population density, above some minimum

Table 8-3. Forage yield of non-irrigated Sart and Tracy sorghums as influenced by seeding rate, Texas A&M University Farm near College Station, 1955.

	Sart			Tracy		
Seed, lb./acre	Green weight, tons/acre	Dry weight tons/acre	Moisture percent	Green weight, tons/acre	Dry weight, tons/acre	Moisture percent
4	14.1	4.6	67.4	10.0	3.4	66.4
8	17.8	5.8	67.4	12.8	4.2	67.5
12	17.9	5.1	66.7	11.7	4.0	65.5
16	17.8	6.2	66.7	13.2	4.6	65.2
L.S.D.[1]	3.4	1.3		1.5	0.5	

[1]The difference in yield must equal or exceed the amount shown to give odds of 19 to 1 that such difference is real and not due to chance (Holt and Smith, 1956).

level, has little or no influence on yield or on moisture content at harvest (Table 8-3). Only a small effect of population density on yield and stalk:head ratios also has been shown with a wider range of forage crops (Table 8-1). Corn, forage sorghum, and grain sorghum differ in total production potential, but they are similar in lack of response to plant distribution and plant density above a basic planting rate. The crops differ even more widely in the ratio of forage to grain (head or ear) in the total dry matter. Plant distribution (row spacing) may have a small effect on stalk:head ratios, with the highest percentage heads occurring in wide rows with all crops. Plant density within a plant distribution pattern shows no consistent effects on stalk:head ratios.

Broadcast or close-drilling of corn has been practiced in some areas, but the practice has not been evaluated in Texas. Based on the experiences with other crops and indications from 20-inch rows (Table 8-1), it seems likely that the practice would reduce the percentage of grain in the forage and thus defeat at least a part of the purpose or value of corn. It seems evident that a wide range of production practices are acceptable for silage crops with no major influence on yield level. If however, plant size and grain production are important, seeding rate is a major consideration.

Factors Influencing Yield

Numerous factors influence silage yields, including soil type and condition, fertility, soil moisture, type of crop, length of growing season required, stage

of maturity at harvest, and method of harvest. Soils and fertilizer practices are discussed, at least generally, elsewhere in this publication.

It has been suggested previously that forage sorghum hybrids generally are higher yielding than corn and grain sorghums. Within the forage sorghums, length of time required to reach maturity is a major determining factor in yield. The late-maturing types are higher yielding than early-maturing types.

Grain content of the forage may be an important consideration if silage with high digestible energy content is desired. Generally some sacrifice in yield may be necessary if a high grain content is desired. The ultimate in sorghum silage quality is found in grain types which produce the lowest total yields. Information on grain ratios is not available for all the forage sorghum hybrids currently on the market. The extremely late robust types are likely to be very low in grain production and some of these may not even head, while early-maturing hybrids with a high grain:stalk ratio are available.

Stage of maturity at harvest is a major factor influencing yield. Not only yield but also quality and physical characteristics of sorghum forage are influenced by the stage of maturity of the plants at the time of harvest (Table 8-4). Forage harvested

Table 8-4. Effect of stage of maturity and variety on yield, percent moisture and leaf-stem-head ratio of several silage sorghums, Angleton, 1961 and 1959.

Variety	Stage of maturity at harvest	Tons dry forage/acre	Percent moisture in green forage	Percent of total forage Leaf	Stem	Heads
Tracy	Boot	5.1	82.9	39	59	2
	Flower	6.1	79.9	29	68	3
	Milk	7.5	73.9	23	70	7
	Dough	7.7	71.5	24	72	4
Silo King	Boot	3.3	83.7	51	45	4
	Flower	5.2	78.0	30	54	16
	Milk	6.2	74.4	27	52	21
	Dough	7.0	71.8	19	43	38
Beef Builder	Boot	5.5	81.2	40	58	2
	Flower	8.1	74.9	31	62	7
	Milk	9.1	72.6	24	63	13
	Dough	10.0	69.3	26	51	23

Holt, Riewe and Cook, 1963.

in the dough stages is lower in moisture content and higher in grain percentage than forage from earlier stages. Maximum dry matter production is reached by most varieties and hybrids by the milk to soft-dough stages. Harvesting in immature stages (preboot and boot) reduces dry matter production as much as 40 to 50 percent. A regrowth cutting may be obtained with early-maturing types harvested in immature stages, but total production is still reduced.

HARVESTING, STORING, AND FEEDING

Preservation of quality is equally as important in storing forage crops as it is during the field-drying operation. Therefore, it is important to provide storage structures and conditions that will insure preservation of quality during the storage period. This is true for both hay and silage, but it is more important for silage because of the high moisture content at the time it is stored.

Types of Silos

Silos may be classed generally as either upright or horizontal. High-quality forage can be produced in either type of structure if air is excluded. It is important to ensile both direct-cut and wilted forage as rapidly as possible to prevent deterioration in quality.

Upright Silos

Upright silos are constructed from a wide variety of materials, including concrete, tile, steel, and glass-coated steel. Inside walls should be smooth and free from cracks and other openings which might be a source of air penetration. Adequate drainage should be provided to prevent saturation of the forage at the bottom of the silo.

Air-tight structures, especially designed for haylage, are available commercially. In these silos haylage can be stored without tramping. These structures are well suited to intermittent filling or feeding.

Plastic bag silos or heavy galvanized wire fence with a lining of reinforced waterproof paper or plastic is effective in preserving silage; however, considerable labor is required to load and unload these temporary stacks. The plastic also punctures easily and requires frequent patching. These types of silos are not considered practical for storing large quantities of silage.

Horizontal Silos

Trench, bunker and stack silos are relatively inexpensive and are considered practical for storing and feeding silage. Trenches or bunkers are recommended where the use of silage is a permanent part of the livestock feeding operation since they have walls which make it possible to obtain tighter and more uniform packing. Stack silos are less expensive to build, but since they have no walls, it is difficult to form the stack and pack the silage tightly. Horizontal stacks can be placed in pastures or at other locations accessible for ensiling and feeding the forage. Stack silos are recommended only when available forage exceeds the capacity of other types of silos.

Trench silos are nothing more than trenches dug in the ground. They should be dug to allow drainage and access by machinery. The sidewalls may have no lining or may be lined with concrete, wood, or other suitable material.

The results of feeding experiments at the Spur Station from 1930 to 1934 demonstrated the effectiveness of water conservation practices for producing forage sorghums and of the trench silo for storing them for extended periods of time, giving rise to the State-wide trench silo program launched by the Texas Agricultural Extension Service in the last half of the thirties. The trench silo became a popular method of storing silage in Texas.

Bunker silos are built with the floor at or above ground level. Thus, the sidewalls require support. Sidewalls may be constructed of concrete, preservative-treated lumber, or some other decay-resistant material. In the Gulf Coast area of Texas untreated lumber in some wall sections has rotted within one year while walls constructed of creosoted lumber have been used for five seasons with no signs of deterioration.

Stack silos are formed by packing silage directly on the ground or on a concrete slab (Figures 8-1 and 8-2). Stack silos should not be less than 16 feet wide. This minimum width is recommended because it permits more uniform packing than obtained with narrower widths. Also, it is not safe to drive trucks and tractors over stacks less than 16 feet wide after the silage is piled higher than 5 feet. The width and height of the stack should permit the use of standard widths of plastic film covering.

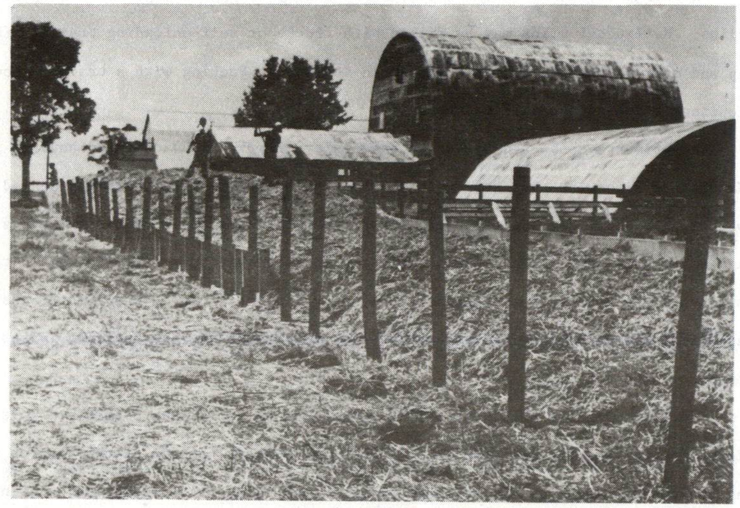
Figure 8-1. Stack silos were formed by stacking silage directly on the ground or on a concrete slab. A minimum width of 16 feet is recommended.

For example, with plastic sheeting 32 feet wide and 100 feet long, maximum dimensions of the stack could be 20 feet wide by 90 feet long by 5 feet high.

A concrete floor in horizontal silos is essential for satisfactory feeding and removal of silage during wet weather. A 4-inch reinforced slab provides adequate support for trucks and tractors during the filling and packing operations. It is also important to provide good drainage by sloping the slab toward one end, or in bunker and stack, from the middle toward each end or to one side. A slope of 1 inch in 10 feet of length is consider a minimum for self-feeding.

Harvesting and Filling

A conventional forage harvester or a flail-type harvester (rotary chopper) can be used to harvest and chop the forage. However, a shorter and more uniform cut, which packs more efficiently and is easier to remove from the silo, is obtained with the conventional harvester.



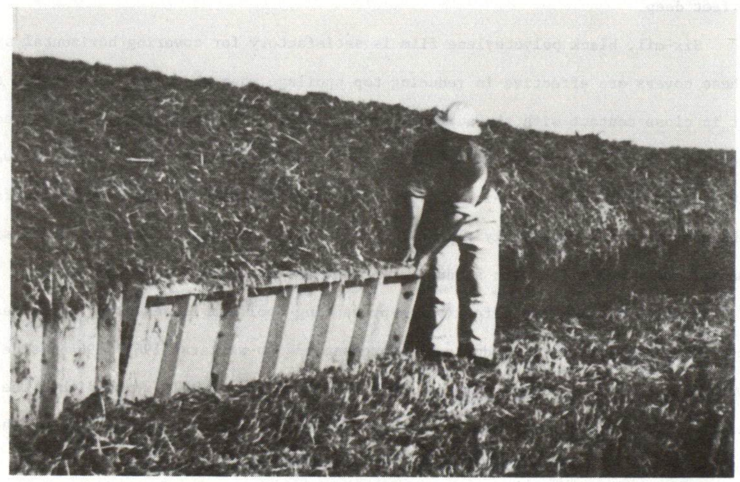


Figure 8-2. Temporary sideboards are helpful in forming stack silos. Posts are set loosely in slightly oversized holes (top). Posts and walls are removed after stack is formed (bottom).

A silage blower or elevator is used to convey chopped forage to the top of upright silos. Horizontal silos may be filled with trucks or self-unloading trailers that move up and over the silage as it is placed in the silo. Packing with a tractor should be continuous during the filling operation.

Experiments conducted at Purdue University (Perry, 1967) compared haylage from a Harvestore silo with that stored in an open-top concrete silo, which was sealed with a plastic cap until feeding was begun. Performance of haylage from the two types of storage structures was similar. Measurable top spoilage was held to a minimum in the open-top silo when the haylage was sealed securely with a plastic cap at the time of ensiling. The use of direct-chop material was not an effective sealer against spoilage in another open-top silo tested.

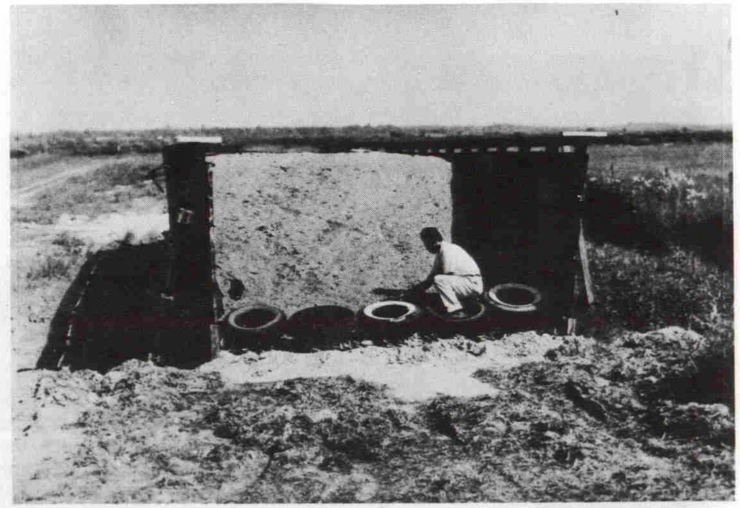
Horizontal silos should be filled and sealed as quickly as possible. This is more important for stack silos than for trenches and bunkers because of the greater surface area exposed. Stack silos should be small enough to permit filling and covering in 2 days or less. This has been accomplished with silos up to 24 feet wide by 90 feet long by 6 feet deep.

Six-mil, black polyethylene film is satisfactory for covering horizontal silos. These covers are effective in reducing top spoilage when the cover is weighted to hold it in close contact with the surface of the silage. Top spoilage can be reduced, but not completely eliminated, by weighting the top with old automobile tires. However, it is found that a 4- to 6-inch layer of sawdust spread uniformly over the surface of the plastic cover completely eliminates top spoilage in both bunker and stack silos. Bunker and stack silos with sawdust coverings are shown in Figure 8-3.

Tight sidewalls are effective in preventing spoilage losses along the sides in bunker silos. In tests conducted by Sorenson and co-workers (1961, 1964), side spoilage was never completely eliminated in stack silos but was greatly reduced when the edges of the plastic cover were sealed airtight. This was accomplished by burying the edge of the cover in a trench and covering with 8 to 10 inches of soil.

Mechanical Unloading

Upright silos can be equipped with mechanical unloaders to remove silage or haylage.



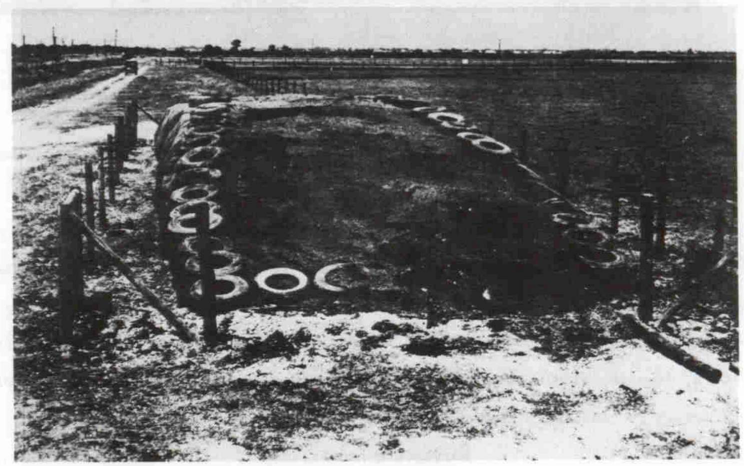


Figure 8-3. A plastic film cover with a 4- to 6-inch layer of sawdust spread uniformly over the cover is effective in eliminating top spoilage in bunker silos (top) and in stack silos (bottom).

When used in conjunction with a mechanized feeder to transport feed to animals, a completely mechanized system for storing and feeding is provided.

Several makes and models of commercial mechanical unloaders suitable for horizontal-type silos are available. However, some of these are self-contained units, and others are designed and constructed so that rigid support of the tractor or power unit is required. Some of the tractor-mounted machines require a considerable amount of time for mounting and dismounting and for all practical purposes tie up a tractor during the unloading and feeding season.

The experimental silo unloader (Figure 8-4) was developed for mechanically unloading

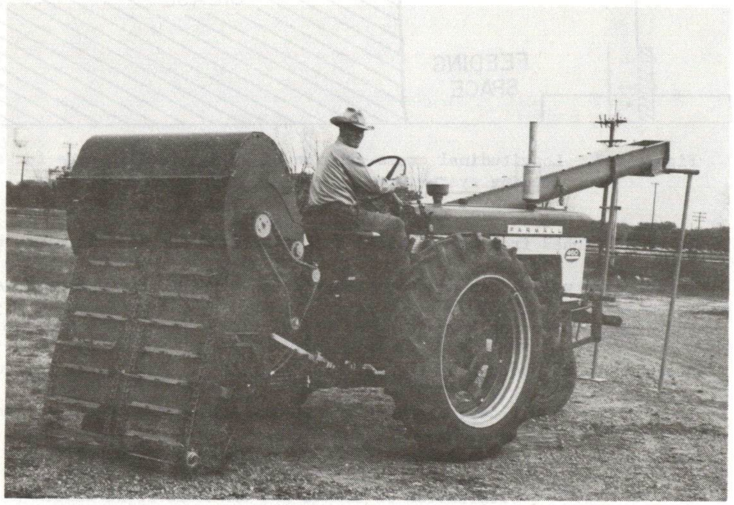


Figure 8-4. View of an experimental unloader for horizontal silos. The unloader is put into operation by backing the tractor into the silo until the digging portion of the unloader comes in contact with the silage. With the tractor brakes locked, the unloader, mounted on telescoping arms, is then forced into the silage with the tractor hydraulic system.

horizontal silos (Sorenson, et al., 1964). The machine consists of a power take-off operated digging attachment mounted on implement coupling beams for two-point, fast-hitch attachment to a tractor. The two-point hitch permits one man to attach and detach the machine from the tractor quickly making the tractor available for other purposes when the unloader is not in use. The unit can be converted to a standard three-point hitch system with minor modification. A maximum capacity of 7.3 tons of silage per hour has been obtained with this machine in tests with sorghum and clover silages. The capacity can be increased by increasing the width of the digging attachment and with experience in operating the machine.

Self-Feeding Silage

The self-feeding of stacks and bunker-stored silage is a practical and labor-saving method of feeding silage to beef and dairy cattle. A concrete floor in the silo is necessary to keep cattle out of the mud during the wet weather. The most efficient operation is self-feeding from both ends of the silo at the same time. When this is done the silo floor should be sloped from the center toward each end or to one side to provide drainage away from the silage.

Different types of feeding gates are shown in Figures 8-5 and 8-6. An electric-pipe gate and a stanchion-type gate have been the most satisfactory. Small calves work their way through the openings in the stanchion gates and damage the silage. The electric-pipe gate, suspended at a height of from 18 to 28 inches from the silo floor, will prevent this. Four to 6 inches of feeding space per animal is adequate for self-feeding silage on a 24-hour-a-day basis. A minimum of 6 inches of feeding space is recommended for producing dairy cows. A maximum silage depth of 6 feet, before settling, is desirable for self-feeding.

A modified, silage self-feeding system for beef cows has been used at The Texas Agricultural Experiment Station at Angleton (Lippke, 1972). The main advantage to this method of feeding over the usual self-feeding method is the reduction in the amount of silage wasted.

Under this system two groups of approximately 25 cows each are fed alternately at each end of a bunker silo 32 feet wide. The restraining gates (Figure 8-7) are located

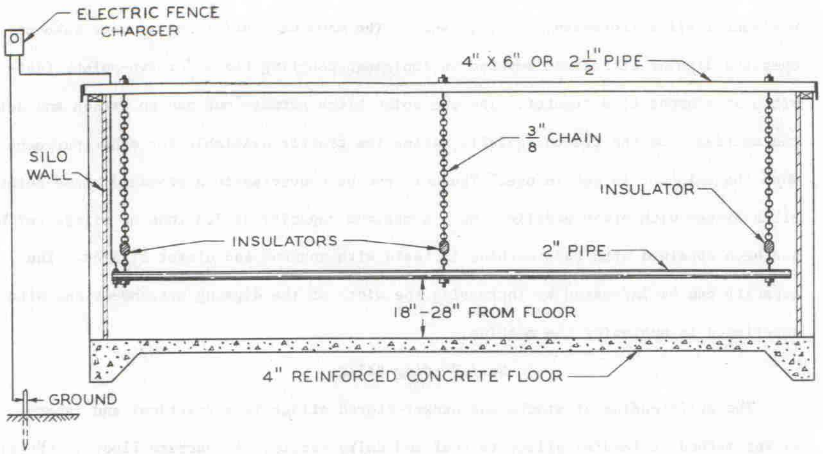


Figure 8-5. An electric-pipe feeding gate for horizontal silos consists of a fence charger and a 2-inch diameter pipe suspended 18 to 28 inches from the floor. Cattle eat over and under the pipe.

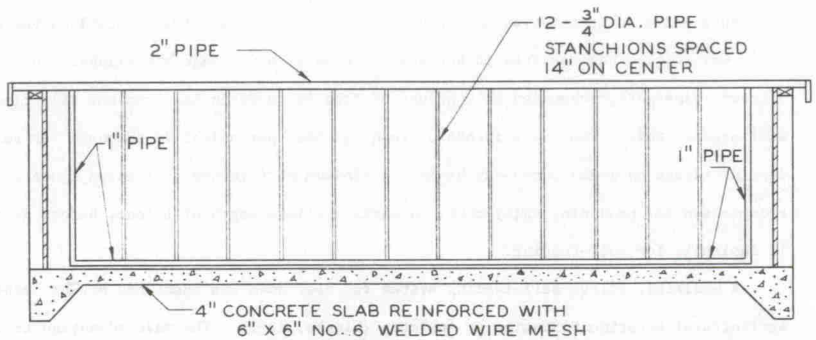


Figure 8-6. Construction details for stanchion-type feeding gate for horizontal silos. When this type of gate is used for stack silos, a fender attached to each end of the gate and extending along the edge of the slab will help prevent wastage of silage.

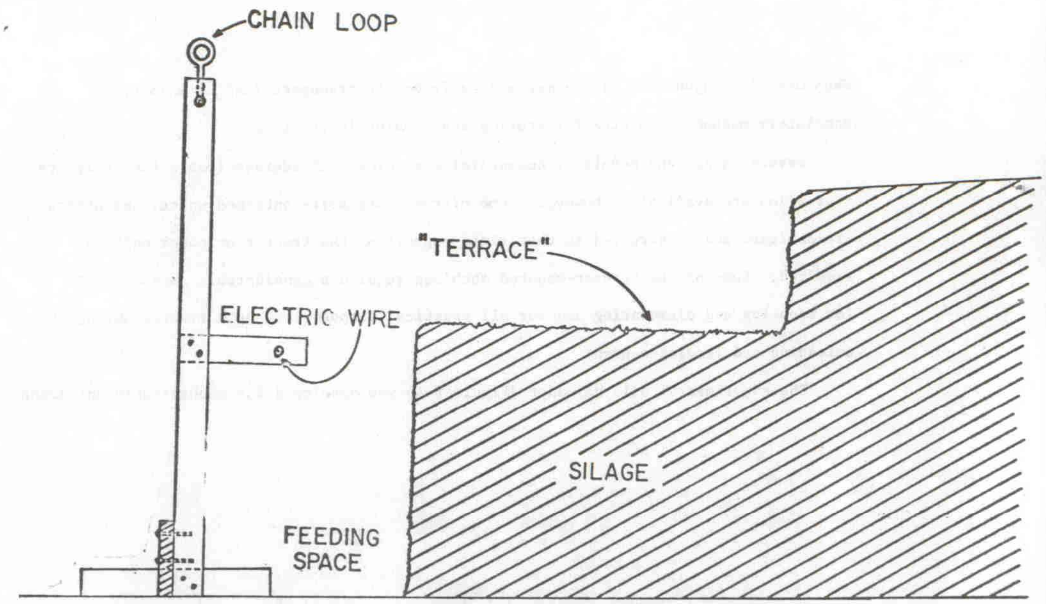


Figure 8-7. Longitudinal cross-section of silage feeding area for a modified self-feeding system.

24 to 30 inches from the vertical silage surface and held in place by light chain anchored to the silo walls. As needed, silage is scooped and raked from a terrace 4 feet in width and dropped into the space between the vertical silage face and the retaining board shown attached to the bottom of the gate in Figure 8-7. This space has sufficient capacity to feed 25 cows for 1 day. Feeding and moving 100 cows with calves requires about 1 hour daily; removing top spoilage and manure averages 3 hours per week.

UTILIZATION OF SILAGE AND HAYLAGES BY LIVESTOCK

Beef Cattle

Silages are used for all phases of beef cattle feeding. The principal silage crops in Texas are the sorghums and corn. Grasses and legumes have not received the attention given them farther east and north in the United States.

Supplementing High-Silage Rations

Prior to the development of combine types of grain sorghum, Texas cattle feeders often had supplies of forages (silage and/or bundle feeds), while fattening grains were scarce and high in price. Protein supplements such as cottonseed meal and peanut meal were usually available at a fair price. This resulted in the use of cottonseed meal and silage for fattening yearling and 2-year old cattle. The main question had to do with quantities of cottonseed meal which should be fed in addition to the full feed of silage, not only for protein supply but as an energy source, since the meal was often less expensive than grain. A further consideration was the oil content of the meal which often ran 7 to 9 percent, thus increasing the energy content of these low-grain rations.

Between 1935 and 1938 (Jones et al., 1942) three experiments were conducted to determine the feasibility of fattening Hereford yearling steers using a full feed of Sumac sorghum silage supplemented with varying levels of cottonseed meal and cottonseed oil. The Sumac silage was a sweet type with approximately 75 percent water content and a low content of small, hard, brown seed. Its digestible energy content was therefore quite low, and adding high energy feeds to the ration gave improved animal performance (Table 8-5). Later work showed that ground Hegari fodder, a grain variety, had considerably greater value as a fattening feed than ground Sumac fodder. When larger amounts of grain were added to the ration this was not true. However, the superiority of a grain variety as either fodder or silage is dependent upon the ability of the animal to utilize the grain efficiently. Even though it is moist, the relatively mature grain in most sorghum silage requires processing by grinding or rolling for efficient utilization (Riggs and McGinty, 1970).

Silages made from high yielding sorghum varieties are low in protein. Values of 2.5 percent on fresh basis or 8.5 percent on air dry basis are common. These values are below recommended levels for growing and finishing young cattle as well as for bulls and lactating cows, assuming their dry matter intake is adequate to meet energy requirements. Calcium and phosphorus contents are also low. Unless these requirements are met through adequate supplementation, the intake of silage may be severely restricted due to inability of the rumen microorganisms to function normally. Animal performance will be low as shown in Figure 8-8 (Galvez, 1948).

Feedlot Growth and Silage Utilization

The rapid growth of cattle feeding has caused increased demand for roughage, leading

TABLE 8-5.
PERFORMANCE OF HEREFORD YEARLING STEERS FULL FED SUMAC SORGHUM SILAGE, WITH GRADED LEVELS OF COTTONSEED MEAL AND COTTONSEED OIL FOR 165 DAYS, Spur, Texas, 193 38

Treatments: Level of cottonseed meal, lb.	4.0	5.5	7.0	4.0	4.0
Level of cottonseed oil, lb.	0.2	---	---	0.6	1.0
Sumac sorghum silage	All groups full fed				
Number of steers	30	30	30	30	30
Initial weight, lb.	724	725	724	723	724
Final weight at feedlot, lb.	1015	1035	1045	1026	1049
Final weight at Ft. Worth market, lb.	936	956	964	946	971
Gain basis feedlot weight, lb.	291	310	321	303	325
Gain basis market weight, lb.	212	231	240	223	247
Daily gain, feedlot basis, lb.	1.76	1.88	1.95	1.84	1.97
Daily gain, market basis, lb.	1.28	1.40	1.45	1.35	1.50
Shrink feedlot to market, %	7.78	7.63	7.75	7.80	7.44
Total feeds consumed, lb.					
Cottonseed meal	650	876	1128	647	643
Cottonseed oil	29	---	---	94	158
Dry roughage	456	469	443	449	447
Sumac silage	6741	6723	6685	6476	6436
Salt	8	7	7	6	7
Dry matter (salt not included), lb.	2694	2882	3082	2685	2736
Daily feed intake, lb.					
Cottonseed meal	4.0	5.5	7.0	4.0	4.0
Cottonseed oil	.2	---	---	.6	1.0
Dry roughage	2.8	2.8	2.7	2.7	2.7
Sumac silage	40.9	40.8	40.6	39.3	[illegible]
Dry matter	16.4	17.6	18.9	16.3	16.7
Dry matter per cwt. gain, lb.					
Feedlot basis	9.3	9.3	9.6	8.9	8.4
Market basis	12.7	12.5	12.8	12.0	11.1
Slaughter and carcass data					
Warm carcass weight, lb.	581	599	614	599	[illegible]
Dressing %, feedlot basis	57.2	57.9	58.8	58.4	58.0
Dressing %, market basis	62.1	62.7	63.7	63.3	62.6
Carcass grades*	18.0	16.4	16.4	16.9	17.5

* Carcass grades: High good - 14; average good - 16; low good - 18.

to greater interest in silage among Texas feedlot operators. Corn silage is favored because of better quality, but sorghum silage is also important because of higher production under irrigation in the areas where most feedlots are located.

Expansion of finishing lots increased demand for feeder cattle, creating an opportunity for some lots to grow calves for finishing through the use of high silage rations. The extent of such development has been minimal, however.

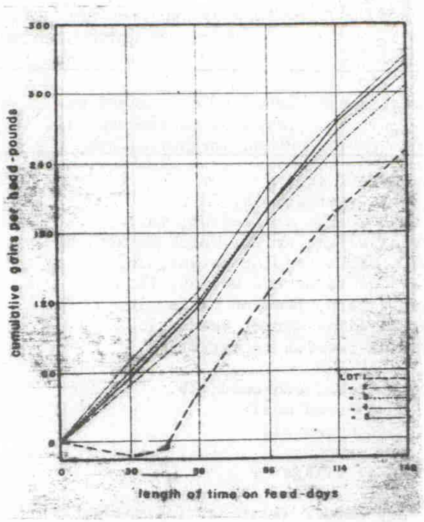


Figure 8-8. Gains of cattle fed sorghum silage rations as influenced by protein supplementation. Lot 1 - no supplement during the first six weeks, then supplemented. Lots 2, 3, 4 & 5 - supplemented continuously.

Silage for Maintaining Beef Cows in Confinement

Rising land prices have focused attention on more intensive systems of cattle management. Considerably greater numbers of cattle can be maintained per unit of land when confined than when conventionally grazed.

At the western edge of the Rolling plains, ranches are stocked at approximately 20 acres per animal unit. Sorghum silage grown on dry land may yield 7.5 to 15 tons per acre, enough to feed 0.75 to 1.50 beef cows for a year in complete confinement (Riggs, 1971). Hereford females have subsisted in confinement for 13 years on sorghum silage with short periods of green chop plus protein and mineral supplements, and a small amount of alfalfa hay during the 75-day breeding season each year. Sorghum silage and green chop provided nearly 75 percent of the total digestible nutrients consumed by these cows.

Silage intake was restricted after the first 2 years when it became clear that a full feed of sorghum silage plus supplement would fatten these females excessively. During

the first 8 years the cows in drylot averaged approximately 100 pounds heavier than their contemporaries on pasture with the same supplementation; yet the two groups showed almost identical production. Reducing silage enough to eliminate the extra weight on the confined cows would further enhance the acre livestock production from silage crops. However, reduction of silage allowance requires careful adjustment of the supplement to assure that the requirements for protein, minerals and vitamin A are met.

Corn Silage

Perry (1964) reviewed research results with corn silage for fattening cattle during the period 1953 to 1964 and made the following summary statements.

"The practice of ensiling the entire green corn plant is not new. In past years such silage was fed in limited amounts--perhaps replacing one-half the hay equivalent--to fattening cattle being fed approximately two percent of their live weight daily as concentrates and one percent as dry roughages. More recently, newer knowledge has shown that much higher levels of corn silage can be used in cattle fattening operations as a means of producing similar quality product at a lowered feed cost per pound of gain. In fact, a full feed of corn silage, when fed with a relatively small amount of concentrates as a nutritional balance, can provide the major portion of a fattening ration for calves or yearlings. Based on the review of literature presented in this paper, the following statements characterize corn silage as a feed for fattening cattle:

1. It is deficient in protein - feed supplemental protein.
2. On high corn silage rations, supply at least a portion of the supplemental protein as natural protein.
3. Antibiotics are especially beneficial in high corn silage rations - feed 75 mg. per day.
4. Feed vitamin A with corn silage.
5. It is a high energy feed and, when properly balanced, can replace 75 to 90 percent of the corn in the fattening ration.
6. Feed costs per pound of gain and TDN requirements per pound of gain are almost always less on high corn silage rations. (Than on high corn grain rations.)
7. Corn silage feeding can more than double the beef tonnage produced per acre of corn harvested. (As compared with harvesting and feeding the corn grain.)
8. It has more energy potential and less protein than legume silage - corn silage is one of the most superior roughages.
9. Addition of small amounts of hay to corn silage ration is of doubtful value.
10. The addition of one-half to one percent of limestone at time of ensiling improves the feeding quality of corn silage.
11. High energy "butt" or "center cut" corn silage is of little more value than regular corn silage.

12. Fertilizer practices may affect feeding quality of corn silage."

Corn capable of yielding 100 to 120 bushels of air-dry grain per acre provides a rather high energy silage, which, when properly supplemented, makes a ration capable of producing gains of 2.2 to 2.5 pounds per day on yearling cattle and of fattening them in 150 to 180 days. Such silage would be expected to provide a considerably higher level of energy than the Sumac sorghum silage used in the Texas trials.

While variations in maturity of sorghum greatly influence the nutritive value of the silage for dairy cows, the stage of maturity of corn silage does not appear highly critical for beef cattle. Dry corn silage makes good feed. Ohio work (Klosterman et al., 1963) showed that heifers fed mature silage (78 percent of the leaves and all husks quite dry and corn grain containing 30 percent moisture) consumed slightly more silage dry matter and gained slightly faster than heifers fed regular silage (a few husks and bottom leaves dry). Digestibility of the stalk and leaf dropped very little after August 15, indicating little difference in feeding value due to harvesting at normal versus later stages of maturity (Johnson et al., 1963). No doubt, there are limits to this concept, however.

Low Energy Silages

Corn and sorghum stalks remaining in the field after grain harvest are a potential energy supply for ruminants. They are estimated to represent 40 percent of the total feed value of the corn crop. About one ton of hay-equivalent is left in the field for each 30 bushels of corn grain harvested. Corn yielding 100 to 150 bushels per acre could be expected to provide four to six tons of hay equivalent. The yield and quality of forage from hybrid grain sorghums after grain harvest are considerably less than for corn, making mechanical harvesting uneconomical. Only about three tons per acre of 60 to 70 percent moisture forage have been obtained. The feed value of the forage is dependent upon the stage at which the grain is cut, normally 15 - 18 percent moisture in the major grain sorghum belt. If the grain is harvested while yet high in moisture, the green forage is expected to be higher in nutritive value than after it has dried. Generally these roughages contain from 4.5 to 6.4 percent crude protein, 27 to 35 percent fiber and 40 to 50 percent nitrogen-free extract. They are also low in phosphorus, calcium, and carotene, so proper protein, mineral, and vitamin A supplementations are necessary.

Roswell Garst (personal communication, March, 1972) makes a strong case for the use of sorghum stubble silage as a feed for beef cows to enhance beef production and income on Iowa farms. His summary follows.

"Anyone who plants a field of grain sorghum reasonably early in the season, which will have the grain down to 25 or 30 percent moisture by September 15 or 20, can have lots of cow feed for less than nothing.

Combine the grain as soon as the moisture falls below 30 percent. Grind the high moisture grain and ensile it. The ensiled grain will be about 18 percent more efficient than ground, dry grain for fattening cattle.

The stalks and leaves carry about twice as much moisture as the grain, so when the grain is 25 to 30 percent moisture the forage will run 50 to 60 percent moisture. On a dry weight basis, the grain will weigh about the same as the stubble if head size is fair. If the stand is excessively thick, head size will be small and there will be more stubble than grain. But figuring a 6000-pound grain crop (15 percent moisture) there should be about 10,000 pounds or 5 tons of 50 percent moisture stubble per acre. Before frost the leaves will be green. If the stubble is chopped fine it will ensile perfectly and contain enough protein for dry beef cows. Only supplemental minerals and vitamin A are needed.

By harvesting the stubble for silage, the ground can be prepared for planting the next crop with a single disking; otherwise it will be necessary to shred the stubble with a rotary shredder, followed by disking and plowing. In short, you can chop and ensile the sorghum stubble, disk once and plant with less labor and expense than you can shred, disk, plow, disk the plowed ground and plant. Hence - cow feed for less than no cost."

Bred yearling heifers fed 37 pounds of corn stover silage (72 percent moisture) supplemented with two pounds of a 32-percent protein supplement fortified with the necessary minerals and vitamin A, gained about 0.8 pound per day during a 98-day wintering period at Purdue University (Perry et al., 1965). When 2 pounds of cracked shelled corn were added to the ration, daily gain increased to 1.1 pounds or 37 percent, indicating the basically low energy value of stover silage. Mature pregnant cows have been satisfactorily wintered by self feeding sorghum stover silage with a salt-cottonseed meal-mineral supplement at Texas Agricultural Experiment Station (TAES).

Because of the low energy value of stover silages, their use should probably be limited to the maintenance of breeding stock, to growing stocker cattle in which only low gains are desired, or to use at very low levels to perform a roughage function in high energy fattening rations.

Haylage

In the Gulf Coast and East Texas areas it may be impossible to cure the earliest and best cuttings of forage as hay. Frequently the early cuttings may be completely lost. Three alternatives to hay making are artificial dehydrating, haylage, and silage making. At The Texas Agricultural Experiment Station, work with haylage was begun when Harvestores were made available by A. O. Smith Corporation in 1958. These structures have provided excellent storage for moist feeds.

Sudan, Coastal bermudagrass and alfalfa were all placed in storage, averaging 40 to 50 percent moisture. Sudan haylage and hay were made from the same fields. Yields are shown in Table 8-6. These forages were fed to cattle for comparative purposes in one growing and two fattening trials. Alfalfa and Coastal bermuda also were put up as haylage and compared in fattening rations. Composition of the feeds appears in Table 8-7.

Table 8-6. Yield of sorghum grain and sudan forage, Texas A&M University Farm near College Station, Texas 1959-61.

Material	Pounds/acre As harvested	Pounds/acre Dry basis
Moist sorghum grain	4964	3425
Dry sorghum grain	4228	3805
Sudan haylage	6140	3070
Sudan hay	2219	1509

Table 8-7. Percentage composition of feeds (dry basis), Texas A&M University Farm near College Station, Texas 1959-61.

	Water	Crude protein	Crude fiber	Ether extract	Ca	P_2O_5	Carotene mg./lb.
Sorghum grain, dry	10.83	9.86	2.43	3.36	0.18	0.43	-
Sorghum grain, moist	32.65	9.90	2.31	4.10	0.15	0.47	-
Sudan hay	19.00	9.32	29.46	2.70	0.50	0.39	8
Sudan haylage	55.00	11.12	30.64	4.78	0.63	0.36	12
Coastal haylage	45.00	8.80	24.40	3.00	0.75	0.22	117
Alfalfa haylage	39.40	16.20	28.00	2.10	1.02	0.25	51

Sudan haylage provided feed for nearly half a steer more per acre than did hay. Cattle fed haylage in one growing test gained slightly less than those fed hay. Slightly less dry matter consumed from the moist rations resulted in very slightly lower finish than when dry rations were fed (Table 8-8).

Table 8-8. Performance of steers fed sudan hay and haylage in three experiments, Texas A&M University Farm near College Station, Texas 1959-61.

	Hay			Haylage		
Daily gain, lbs.						
Experiment 1 - Growing		1.70			1.55	
Experiment 2 - Fattening		1.91			2.02	
Experiment 3 - Fattening		2.15			2.09	
Average		1.92			1.89	
Feed per 100 lbs. gain*	Rough.	Conc.	Total	Rough.	Conc.	Total
Experiment 1 - Growing	730	290	1020	713	326	1039
Experiment 2 - Fattening	368	736	1104	346	720	1066
Experiment 3 - Fattening	348	546	894	282	572	854
Average	482	524	1006	447	539	986

*Dry matter basis

When alfalfa and Coastal bermudagrass haylages were compared in fattening rations for steer calves, there was essentially no difference in feedlot performance nor in carcass characteristics of the cattle (Table 8-9).

The results from feeding haylage as compared with hay permit several generalizations:

1. Forage crops of good quality can be made into haylage under conditions which do not permit making hay.
2. The haylage operation can be completely mechanized.
3. Wilting or partially drying forage crops materially reduces the tonnage which must be handled and aids in preservation of grass and legume crops.
4. Moist grasses and legumes can be effectively stored in airtight storage without the use of preservatives.
5. Somewhat higher values for protein and carotene have been observed in haylages than in hay. This is attributed partially to less shattering loss of leaf material and partially to less exposure to weather.
6. Cattle performance has been substantially the same when haylage and hay from the same crop have been fed.
7. Carcass characteristics of steers fed haylage were not significantly different from those fed hay as a source of roughage.
8. An acre of sudan harvested as haylage provided feed for about 0.4 steer more than when harvested as hay.

Dairy Cattle

Because of the high level of production attainable in the modern dairy cow, nutrient

Table 8-9. Comparison of alfalfa haylage and coastal bermudagrass haylage for fattening heavy hereford steer calves, Texas A&M University Farm near College Station, August 30, 1961 - March 3, 1962 - 186 days.

Treatment groups	Coastal bermudagrass Haylage	Alfalfa Haylage
Number of steers	22	22
Initial weight, lb.	563	571
Final weight, lb.	992	1012
Average weight, lb.	779	791
Total gain, lb.	429	442
Daily gain, lb.	2.3	2.4
AVERAGE RATIONS:		
Protein supplement, lb.	2.0	2.0
Ground sorghum grain or heads, lb.	12.6	12.6
Roughage, lb	17.1	17.1
DRY MATTER INTAKE DAILY, lb.:	19.6	20.9
DRY MATTER INTAKE DAILY AS % OF AVERAGE WEIGHT:	2.5	2.7
DRY MATTER CONSUMED (LB.)/CWT. GAIN:		
Protein supplement	80	79
Ground sorghum grain	367	360
Roughage	402	444
Total	849	876
Feed cost/lb. gain, ¢*	16.1	18.1
SLAUGHTER DATA:		
Shrinkage, %	3.9	4.4
Cold carcass wt. lb.	550	569
Cold carcass wt./day age	1.2	1.2
Ribeye area/cwt. ch.carc.	1.6	1.6
Fat thickness, in.	0.7	0.7
Carcass grade:		
Quality	16.5	17.4
Yield	4.1	4.3
Sum boneless trimmed cuts, %	47.7	47.5
Sheer force value, lb.	9.7	9.6

*Feed costs based on dry matter equivalent of coastal bermuda hay @ $20 per ton, alfalfa hay @ $30 per ton, cottonseed meal @ $65 per ton, and threshed ground sorghum grain @ $2 per cwt. at 13 percent moisture.

requirements at the peak of her production make it essential that her ration contain only the highest quality constitutents. The need for a high energy roughage has resulted in the increased use of corn silage in those areas where corn can be grown. Corn, expected to yield 80-100 bushels of grain per acre, makes an ideal forage for the dairy cow, and some dairymen have used it very successfully as the sole "roughage" in the diet.

Grain Sorghum Silage

In those areas not suited to corn production because of moisture limitations but where sorghums can be grown successfully, grain sorghums, expected to yield 4,000 pounds or more of grain per acre, have produced silages which were satisfactory as the principal roughage in the diets of high-producing dairy cows. Browning and co-workers (1961) have reported that RS 610 grain sorghum gave superior results to either corn or a medium height sorghum when used as silage in the ration of lactating animals. Leighton and co-workers (1969, 1972) have reported more profitable performance with RS 626 grain sorghum silage than with a dry sorghum grain-sorghum hay ration containing 50 percent grain (Table 8-10). They obtained satisfactory performance with cows producing above 50 pounds

Table 8-10. Summary of costs of rations and performance of cows in milk, College Station, Texas.

Per Cow	Basic Rations: Grain sorghum silage (50% grain in D.M.)	Sorghum grain and hay (50:50)
Dry matter intake daily ave., lb.	39.6	40.4
Milk production daily ave., lb.	35.7	36.7[a]
Feed costs daily ave.	$0.77	$0.97
Body weight change weekly ave., lb.	+7.1	+21.3[a]
Feed costs per cwt of milk, 4% F.	$2.13	$2.64
Daily income above feed costs (per cow)	$1.29	$1.14

[a] $p < 0.01$

of milk per day when fed a ration containing only RS 610 grain sorghum silage plus a free-choice mineral supplement. In this research the sorghums had been cut high, leaving an 8- to 10-inch stubble so that the grain content of the resulting silage averaged 50 percent of the dry matter. The RS 610 silage contained 12 percent protein on a dry matter basis, and no protein supplement was added to the research ration. However, in research with other grain sorghum hybrids, protein varied from 7 to 9 percent of the dry matter, and protein supplements were needed. To one of these, the Texas workers added 8 pounds of urea per ton of sorghum as it was being ensiled and obtained a silage that contained 11 to 12 percent protein on the dry matter basis. The other hybrids used in this research included Pioneer 846, Top Hand, RS 626 and RS 671.

During 1970 the Texas researchers conducted investigations in which a hybrid grain sorghum from the same field was harvested at two stubble heights--3 to 4 inches and 8 to 10 inches. Strips of sorghum left in the field for later combining gave yields averaging 5,300 pounds of grain per acre. The results of a feeding experiment with these silages are summarized in Table 8-11. The higher milk production from the high-cut

Table 8-11. Comparison of high and low cut grain sorghum silages, Texas A&M University Farm near College Station.

	High Cut	Low Cut
Stubble height, inches	8-10	3-4
Av. yield per acre, tons	7.2	8.6
Cost per ton of silage	$16.10	$13.83
Av. daily FCM, lb.	29.8	27.4
Av. daily silage intake, lb.	50.9	46.2
Av. daily silage cost[a]	$ 0.41	$ 0.32
Av. daily value of milk	$ 1.83	$ 1.69
Est. % TDN (in vivo digestion) 35% D. M.	22.4	19.7
Cost per lb. of TDN	$0.036	$0.035

[a]Other feed costs were not significantly different in the two rations.

silage was partially the result of greater daily intakes as well as the higher nutritive value of this silage. Production and harvesting costs, milk prices, and costs of other feeds will be determining factors as to whether the increase in milk will offset the higher cost of feeding the high-cut silage.

Effects of Stage of Maturity

In all of the Texas dairy studies with grain sorghum silage, the crops have been allowed to mature until the grain contained less than 30 percent moisture while the total plant harvested carried 50 to 65 percent moisture. At this stage of maturity, most sorghum seeds will not soften sufficiently in the silo to prevent excessive passage of grain through the cows. However, running the fresh chopped material through a blower which contained a hammer mill from which the screen had been removed (Wetmore mill) resulted in sufficient breakage of the harder seeds so that very little evidence of passage of grain was observed in the feces. Beef cattle research with head-chop silage indicated that grinding prior to feeding was necessary after the heads had been through a recutter in the harvester. Dairy research with mature grain sorghum in 1972

indicated that the recutter on a Gehl did not break up the seed. If the silage is not to be run through a hammer mill-blower, earlier harvest, when the seed is in the dough stage, is recommended for most grain sorghums and all forage sorghums.

In earlier dairy research at TAES Tracy and Atlas sorghums were used in investigations into the optimum stage of maturity at which these crops should be harvested for silage (Leighton and Rupel, 1958; Lippke and Leighton, 1961; and Brown et al., 1963). Results indicate that when soil moisture conditions are favorable, silage sorghums can be allowed to reach the hard dough stage before harvesting, but in dry years harvesting should be started when the oldest seeds are in the soft dough stage, or earlier under severe drouth conditions. However, it should be emphasized that seed hardness in silage varies greatly among varieties and hybrids. Recent digestion trials with dairy heifers fed ORA-T and FS1a silage carrying nearly 40 percent grain in the dry matter revealed the disappearance of 87 percent of the whole seed consumed by the heifers. The hybrids were in the hard seed stage at harvest.

Haylage

Grasses and legumes may be used successfully as either silage or haylage in dairy rations. Research (Voelker and Bartle, 1960) has shown slightly higher dry matter intakes and better performance by lactating dairy cows when they are fed alfalfa haylage compared to alfalfa silage. Research results at TAES (Brown, Rupel and Leighton, 1964) were less favorable when haylage was made from immature sorghum or cereal crops. In 3 years of investigations, the haylage-fed dairy cows failed to produce as much as similar animals on the control diet. The research was designed to compare the effects of a confinement Harvestore feeding regime with the control diet which was the pasture, green chop, silage, and hay roughage program followed with the University herd. During the 3-year study, 84 dairy cows, 41 Holsteins, and 43 Jerseys were assigned to the haylage ration and a similar number to the control feeding regime. As much as possible the groups were kept balanced in terms of stage of lactation, breed, and age.

Haylages were made from Atlas, oats, sudan grass, and from a mixture of alfalfa hay and Atlas green chop. The control group was pastured on oats, sweet sudan, Atlas and common bermudagrass as these forages became available. They received Atlas or Tracy silage, Atlas green chop and alfalfa, and Atlas hays during the period of the research. The same concentrate mixture was fed to both groups.

Cows on the haylage ration were fed at an average cost of 8 cents per day less than the controls during the 3-year period. The average daily milk production of the control groups exceeded that of the haylage fed groups by 4.4 pounds per cow. This resulted in 13 cents per cow per day greater income above feed cost for the control groups over the haylage-fed groups.

SUMMARY (Dairy Cattle)

For lactating dairy cows, well-eared corn silage, where it can be grown, is the best silage and in the drier areas, medium height grain sorghums, cut when the harvested portion of the plant contains 60 to 70 percent moisture. With most varieties or hybrids, the seed should be harvested in the dough stage. If the seed is hard some method of breaking it is usually necessary. Grass and legume silage and haylage should be made primarily to save a crop when weather conditions prevent curing for hay. Grasses such as Coastal bermudagrass are only fair sources of energy, and considerable grain must be fed with grass silage or haylage in the rations of high producing dairy cows. Hay crops should be harvested at the same stage of maturity for silage, haylage or hay, (i.e., early bloom for alfalfa, early boot for most grasses and sorghums, and every 3 weeks for Coastal).

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