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STORING AND HANDLING SILAGE IN HORIZONTAL ABOVE-GROUND SILOS

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CONTENTS

SUMMARY

Research conducted at Beaumont and College Station during 1957-63 resulted in the developing of practical methods for ensiling clovers and grasses during weather too wet and humid for haying.

The addition of zinc bacatracin to forage at the time of ensiling reduced dry matter losses in direct-cut clover silage. Preservatives used in these tests were not effective in reducing dry matter losses in high-moisture (80 percent) sorghum silage.

Silos used were above-ground types designed for low-cost preservation of silage. Covered bunker and stack silos were economical and practical storage facilities that offered flexibility in locating the silos for efficient management practices.

A 4 to 6-inch layer of sawdust spread uniformly over the surface of a plastic film cover eliminated top spoilage in both types of silos. Tight sidewalls were effective in preventing spoilage on the sides in bunker silos. Side spoilage was never completely eliminated in stack silos, but was greatly reduced when the edges of the plastic cover were sealed air-tight.

Self-feeding from bunker and stack silos was a practical and labor-saving method of feeding silage when a concrete floor was used and maximum depth of the silage was 6 feet. Four to 6 inches of feeding space per animal were adequate for self-feeding on a 24-hour-a-day basis.

An experimental silo unloader was developed for mechanically unloading horizontal-type silos. A capacity of 7.3 tons of silage per hour was obtained with the machine in tests with sorghum and clover silages. A commercial unloader, patterned after the experimental machine, but with increased width and capacity, has been built and tested.

Annual costs for harvesting, filling the silo and storing each ton of feedable silage were $4.80 for a 20 by 90-foot bunker silo with concrete floor and preservative-treated lumber walls, compared to $6.54 for the same size stack silo with concrete floor and no walls and $5.40 for stack silos with concrete floor and temporary walls. The lower cost for bunker silos was a result of less labor required for filling, more uniform and tighter packing and less spoilage loss.

Costs of feeding silage per animal unit per day averaged 1.5 cents for self-feeding from one end of the silo, 12.4 cents for two different methods of hand feeding and 9.0 cents for mechanical feeding. Silage was hauled 5 miles in the mechanical feeding tests, compared to 0.5 mile for the hand feeding methods. Based on a hauling distance of 0.5 mile, the cost for mechanical feeding would be approximately 5.8 cents per animal unit per day.

STORING AND HANDLING SILAGE IN HORIZONTAL ABOVE-GROUND SILOS

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In the Gulf Coast area of Texas, the greatest production of pasture forage occurs in the spring when high humidity and frequent rains hinder field processing of hay. Since this production is usually higher than grazing requirements at the time, ensiling is a practical way to preserve the excess for use during periods of low forage production.

Research was started in 1957 by the Texas Agricultural Experiment Station and the U. S. Department of Agriculture to develop structures and improved methods and equipment for storing and handling silage economically on the Coast Prairie. The results obtained during the 3-year period, 1957-60, were reported in MP-525, *Handling Silage in Above-ground Silos on the Coast Prairie*. A copy of this publication will be sent upon request. This report summarizes the results obtained during the period 1961-63.

CROPS USED FOR SILAGE

Legumes, grasses and their mixtures were ensiled at moisture contents of 51 to 85 percent and protein content of 6 to 15 percent (dry basis) during the 3-year period, 1957-59. Species used were persianclover, whiteclover, burclover, sweetclover, ryegrass, canarygrass, dallisgrass, Angletongrass, oats, sorghum almum and Tracy sorghum. Tracy sorghum and common persianclover were ensiled from 1960 to 1962, inclusive, for critical evaluation of preservatives and field drying. Tracy was ensiled at 81 percent moisture and 5 percent protein (dry basis) while common persianclover was ensiled at 78 to 82 percent moisture and 12 to 16 percent protein (dry basis).

MOISTURE CONTENT OF FORAGE

Forage moisture was important in the preservation of silage. When moisture content was high (above 80 percent), drainage of silage juices was excessive. Generally, this silage was dark in color, had a strong putrid odor and was of low palatability. The optimum moisture content was 70 to 75 percent.

The moisture content of forage crops harvested in the early bloom stage was usually 80 to 85 percent. The moisture content of these high-moisture forages was reduced to about 75 percent by mowing and allowing the forage to wilt in the swath for 2 to 5 hours, depending on weather conditions. However, more labor and equipment were involved in handling wilted than unwilted forage. The direct-cut method of handling unwilted forage reduced labor and equipment requirements and minimized the risk of weather damage. It was possible to direct-cut some forage crops at the optimum moisture content and stage of maturity for high-quality silage.

USE OF PRESERVATIVES

Small-scale silos (55 gallon drums) were used to study the effects of methods of harvesting and use of preservatives on dry matter losses in sorghum and clover silages. Grab samples were taken as the forage was ensiled. These samples were placed in each drum at two levels in 1960 and at five levels in 1961 and 1962. The samples were recovered when the silos were opened. Dry matter losses during storage were computed from these samples and from the total forage put into and taken out of the drums. Data were obtained on direct-cut and wilted silages harvested by conventional and flail-type harvesters.

Results of these tests, Tables 1, 2 and 3, were (1) dry matter losses were about the same for forages harvested with the two types of harvesters, (2) zinc bacatracin and sodium bisulfite did not reduce dry matter losses in high-moisture (80 percent) sorghum silage, (3) dry matter losses in direct-cut clover silage were less when treated with zinc bacatracin than when no preservative was used (this was not true for silages treated with sodium bisulfite and propylene oxide); and (4) no significant difference was shown in dry matter losses in treated and untreated wilted clover silage.

Dry matter losses computed from samples and from total forage ensiled were about the same in all tests for untreated silage. However, in some of the tests with treated silage there was considerable variation in dry matter losses computed by these two methods. The changes in dry matter for treated silage were consistently higher when computed on the basis of total forage rather than sample weights, but the same relationship was shown for both methods on the effect of preservative used on dry matter losses. The simple correlation was 0.705 (significant at 1 per-

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TABLE 1. DRY MATTER LOSSES, CRUDE FIBER PERCENTAGE, AND pH OF DIRECT-CUT TRACY SORGHUM SILAGE HARVESTED WITH CONVENTIONAL AND FLAIL-TYPE HARVESTERS AND STORED IN SMALL-SCALE SILOS FOR 6 MONTHS WITH AND WITHOUT PRESERVATIVES, 1960-61

Type of harvester	Preservative used[2]	Moisture content of forage when ensiled, percent	Loss in dry matter, percent		Crude fiber, percent[6]		Final pH
			Forage samples[4]	Total forage[5]	When ensiled	End of storage	
Conventional[1]	None	81.0	9.8	9.4	31.8	35.6	3.7
	Zinc bacatracin[3]	80.8	11.8	17.9	31.0	35.4	3.6
	Sodium bisulfite	81.6	16.7	18.1	31.2	35.6	4.4
Flail-type	None	80.9	12.2	12.5	32.1	37.1	3.7
	Zinc bacatracin[3]	81.1	10.0	12.9	33.4	35.8	3.9

[1]Harvester set for a 3/8-inch cut.
[2]Preservatives were added at the following rates: zinc bacatracin at a rate of 5 pounds per ton of silage; and sodium bisulfite at a rate of 9 pounds per ton.
[3]Zinc bacatracin is sold under the trade name of SILOTRACIN.
[4]Based on initial and final dry-matter weights of samples placed at different levels in each silo as the forage was ensiled. Statistically, these values were not significantly different.
[5]Based on initial and final dry-matter weights of the total amount of forage ensiled. Statistically, these values were not significantly different.
[6]Based on dry weight.

cent level) between dry matter losses computed from samples and dry matter losses computed from total forage.

SILO TYPES AND CONSTRUCTION

Above-ground silos, designed for low-cost preservation of silage, were used in these studies. Above-ground silos were used because underground types frequently flood during the excessive rainfall in the Gulf Coast area. Also emphasis was placed on types of silos offering flexibility of location. Some were located adjacent to winter pastures where cattle could self-feed from them for needed supplemental winter feed.

Plastic bag, bunker and stack silos were used in these tests. A plastic bag silo was effective in preserving silage, but considerable labor was required to load and unload it. The bag also punctured easily and required frequent patching. This type of silo is not considered practical for storing large quantities of forage, usually handled on most farms.

Bunker and horizontal stack silos are relatively inexpensive and considered practical for the Gulf Coast Prairie. Bunkers are recommended where the

TABLE 2. DRY MATTER LOSSES, CRUDE FIBER PERCENTAGE, AND pH OF DIRECT-CUT AND WILTED PERSIANCLOVER SILAGE HARVESTED WITH CONVENTIONAL AND FLAIL-TYPE HARVESTERS AND STORED IN SMALL-SCALE SILOS FOR 10 MONTHS WITH AND WITHOUT PRESERVATIVES, 1961-62

Method of harvesting	Preservative used[1]	Moisture content of forage when ensiled, percent	Loss in dry matter, percent		Crude fiber, percent[4]		Final pH
			Forage samples[2]	Total forage[3]	When ensiled	End of storage	
Direct cut with conventional harvester	None	81.6	10.2	9.0	26.5	26.1	4.5
	Zinc bacatracin[2]	78.8	3.7	1.7	27.8	28.5	4.4
	Sodium bisulfite	78.3	12.6	11.5	22.9	24.3	5.1
Direct cut with flail-type chopper	None	78.3	12.5	11.3	29.9	29.9	4.7
	Zinc bacatracin[2]	82.0	4.8		29.7	32.3	5.0
	Sodium bisulfite	80.9	8.2	9.4	28.5	27.4	5.0
Mow, cure in swath for 2.5 hours, rake and pick up from windrow with conventional harvester	None	77.6	5.3	11.5	27.3	27.1	4.3
	Zinc bacatracin[2]	75.3	4.6	5.6	27.5	27.9	4.3
	Sodium bisulfite	74.1	4.5	10.6	28.0	26.4	5.0
Mow, cure in swath for 2.5 hours, rake and pick up from windrow with flail-type chopper	None	68.4	7.1	12.2	28.2	28.6	4.8
	Zinc bacatracin[2]	69.0	4.6	7.6	27.0	27.7	4.9
	Sodium bisulfite	69.9	6.4	9.7	27.7	28.6	4.8

[1]Preservatives were added at the following rates: zinc bacatracin at a rate of 5 pounds per ton of forage; and sodium bisulfite at a rate of 9 pounds per ton.
[2]Based on initial and final dry matter weights of samples placed at different levels in each silo as the forage was ensiled. LSD (.05) = 4.4; LSD (.01) = 6.0.
[3]Based on initial and final dry matter weights of the total forage ensiled. Statistically, these values were not significantly different.
[4]Based on dry weight.

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 can also be used when available forage exceeds the capacity of bunkers or other types of silos.

The stack silos were formed by packing silage directly on the ground or on a concrete slab, Figure 1. It was found that 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. 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.

Sidewalls of bunker silos should be constructed of concrete, preservative-treated lumber or some other decay-resistant material. Untreated lumber in some of the wall sections of bunker silos used in these tests rotted within 1 year. Walls constructed of creosoted lumber were used for five seasons with no signs of deterioration.

A concrete floor was essential for satisfactory feeding and removal of silage during wet weather. A 4-inch reinforced slab provided adequate support for trucks and tractors during the filling and packing operations. Important also was providing good drainage by sloping the slab toward one end, from the middle toward each end or to one side. A slope of 1 inch in 10 feet of length is considered a minimum for self-feeding.

TABLE 3. DRY MATTER LOSSES FOR DIRECT-CUT PERSIANCLOVER SILAGE STORED IN SMALL-SCALE SILOS FOR 10 MONTHS WITH AND WITHOUT PRESERVATIVES, 1962-63

Moisture content of forage, percent		Preservative used[1]	Loss in dry matter, percent	
When ensiled	End of storage		Forage samples[2]	Total forage[3]
78.4	81.1	None	14.8	17.2
78.9	82.3	Propylene oxide	13.4	28.6
78.3	81.7	None	18.3	18.9
78.1	79.8	Zinc bacatracin	3.5	11.1

[1]Preservatives were added at the following rates: 3 percent solution of propylene oxide at a rate of 10 quarts per 100 pounds of wet silage; and zinc bacatracin at a rate of 5 pounds per ton of silage.

[2]Based on initial and final dry matter weights of samples placed at different levels in each silo as the forage was ensiled. LSD (.05) = 4.2; LSD (.01) = 5.9.

[3]Based on initial and final dry matter weights of the total amount of forage ensiled. LSD (.05) = 3.3; LSD (.01) = 4.6.

Figure 1. Stack silos were formed by packing silage directly on the ground or on a concrete slab.

HARVESTING AND FILLING

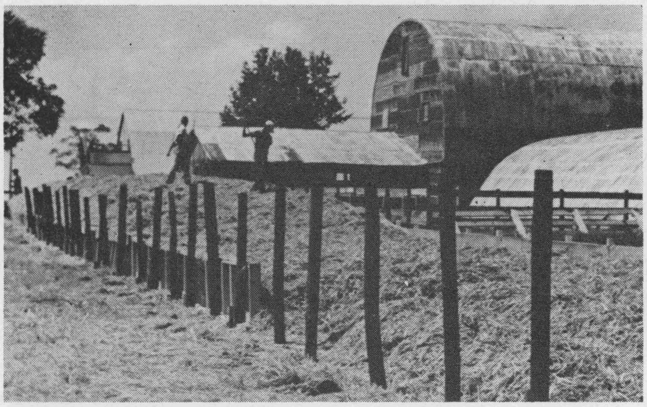
A conventional forage harvester and a flail-type harvester (rotary chopper) were used to harvest and chop the forage. Initial cost and maintenance are less for a flail-type than for a conventional harvester. However, a shorter and more uniform cut, which was more efficient for packing the silage, was obtained with the conventional harvester.

The bunker and stack silos used in these tests were filled with trucks or self-unloading trailers that moved up and over the silage as it was placed in the silo. Packing with a tractor was continuous during the filling operation.

Some difficulty was encountered in maintaining vertical walls on stacks during filling, particularly with short cuts of forage (harvester set for 3/8-inch cut). However, forage cut at longer lengths (1 to 4 inches) was difficult to pack and resulted in higher spoilage losses than occurred in stacks made with short cuts of forage. The use of temporary, short sides (2 feet high) was helpful in overcoming the difficulty in forming the stacks, Figure 2. The short sides allowed the packing tractor to get close to the sides and resulted in tightly-packed, uniform stacks. The sides were removed after the stack was completed and before it was covered. They were then available for use on other stacks.

Several methods were used to support the temporary walls. The use of fence posts, Figure 2, was the most practical method used. The posts were spaced 4 feet apart and were set 18 inches deep in slightly oversized holes. Dirt was not placed around the posts. The posts were left loose to be removed easily after the stack was completed.

Bunker and stack silos were filled and sealed as quickly as possible. This was more important for stack silos than for 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 was accomplished in these tests with silos up to 24 feet wide by 90 feet long by 6 feet deep.



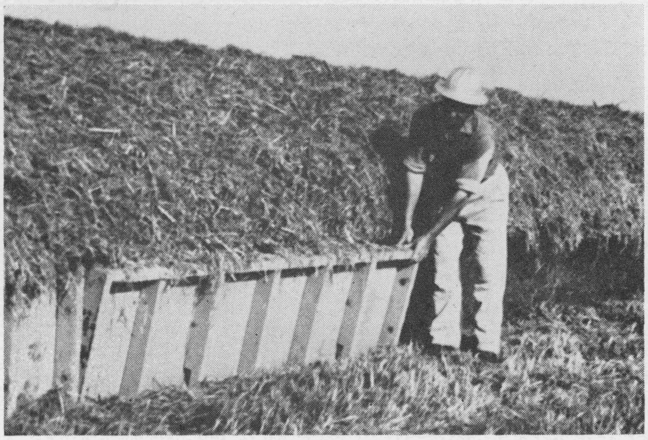


Figure 2. Temporary sideboards were helpful in forming stack silos. Posts were set loosely in slightly oversized holes (top). Posts and walls were removed after the stack was completed (bottom).

SEALING THE SILO

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

Tight sidewalls were effective in preventing spoilage losses along the sides in bunker silos. Side spoilage was never completely eliminated in stack silos, but was greatly reduced when the edges of the plastic cover were sealed air-tight. This was accomplished by burying the edge of the cover in a trench and covering with 8 to 10 inches of soil.

SILAGE DENSITY

Density measurements were made with a 12-inch square metal box, 6 inches deep, open on both ends. The box was placed on the silage at the location where the measurement was to be made and then forced down as the forage was cut loose from around the edge of the box. Measurements were made at different depths and at several locations in the silo.

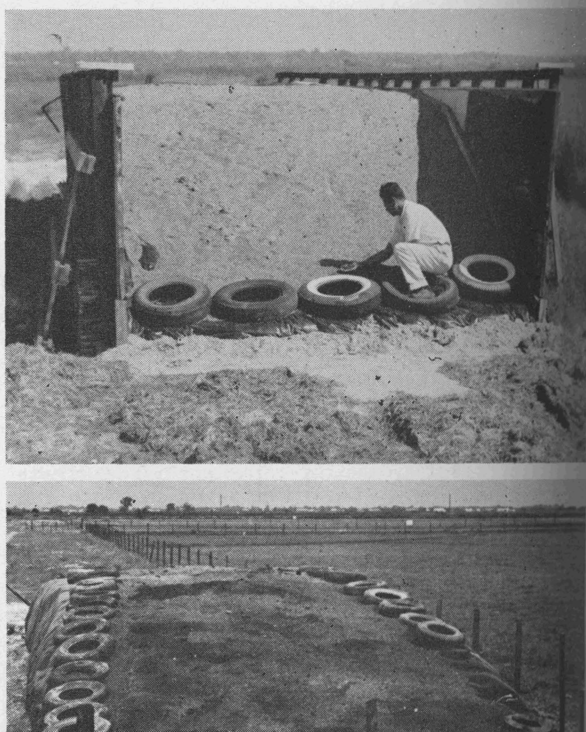
The density of silage was affected by such factors as the length of cut, moisture content and depth of the ensiled forage, type of silo, amount of packing during the filling operation and type of forage ensiled.

Densities of direct-cut sorghum silage and persianclover silage, stored at a depth of 6 feet in bunker silos, ranged from 45 to 55 pounds per cubic foot, with the highest values for persianclover silages. Densities of the same silage materials stored at a 5-foot depth in stack silos ranged from 35 to 42 pounds per cubic foot. The values given are averages for the silo.

SELF-FEEDING SILAGE

The self-feeding of stacks and bunker-stored silage was a practical and labor-saving method of feeding silage to beef and dairy cattle. However, in tests conducted at Texas A&M University, some high-producing dairy cattle did not obtain sufficient silage under a self-feeding program.[1] A concrete floor in

[1] M. A. Brown, personal communication. Dairy Science Department, Texas A&M University, College Station, Texas. August 1963.



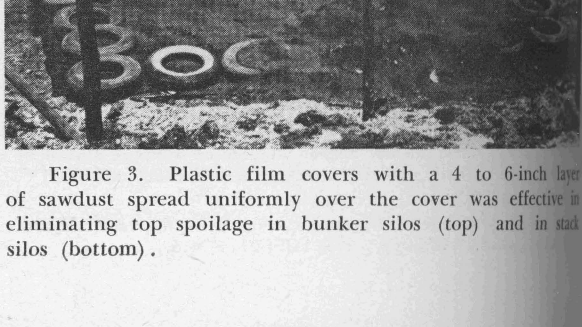


Figure 3. Plastic film covers with a 4 to 6-inch layer of sawdust spread uniformly over the cover was effective in eliminating top spoilage in bunker silos (top) and in stack silos (bottom).

the silo was necessary to keep cattle out of the mud during wet weather. The most efficient operation was 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.

Several different types of feeding gates were used. An electric-pipe gate and a stanchion-type gate, Figures 4-6, inclusive, proved the most satisfactory. Small calves worked their way through the openings in the stanchion gates and damaged silage. The electric-pipe gate, suspended at a height of from 18 to 28 inches from the silo floor, prevented this. Four to 6 inches of feeding space per animal was 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, was found desirable for self-feeding.

MECHANICAL UNLOADING

Several makes and models of commercial mechanical unloaders which are 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 silo unloader, Figure 7, is an experimental machine developed by agricultural engineers of Texas A&M University for mechanically unloading horizontal silos. 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 quickly attach and detach the machine from the tractor, 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 modifications.

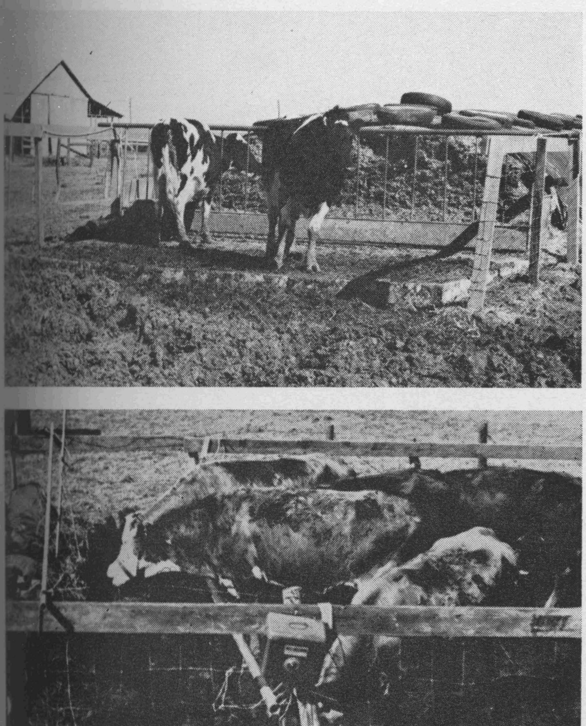


Figure 4. The self-feeding of stacks and bunker-stored silage reduced labor costs. Stanchion-type gate (top) and electric-pipe feeding gates proved satisfactory. To self-feed, plastic cover was rolled back and gate pushed ahead.

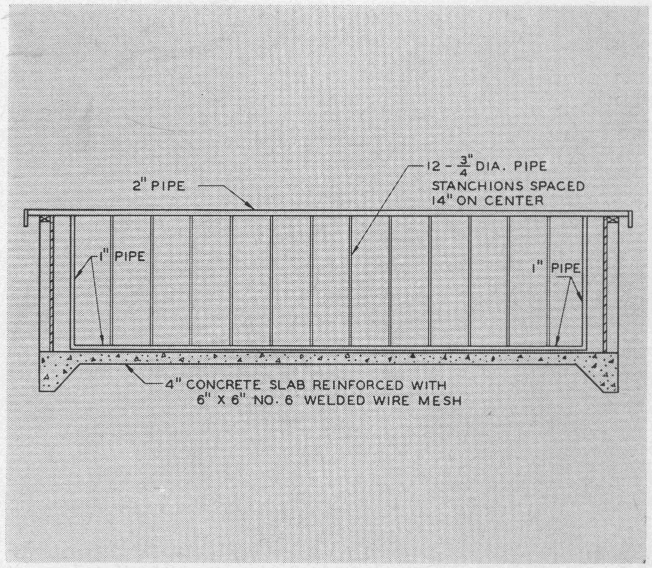


Figure 5. Construction details for stanchion-type gate. This type of gate also can be constructed of wood.

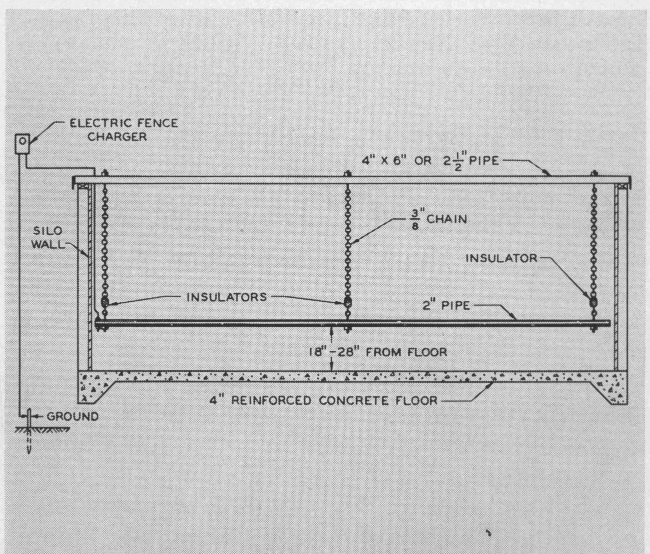


Figure 6. An electric-pipe gate consists of a fence charger and a 2-inch diameter pipe suspended from 18 to 28 inches from the floor and 12 inches from the silage. Cattle eat over and under the pipe.

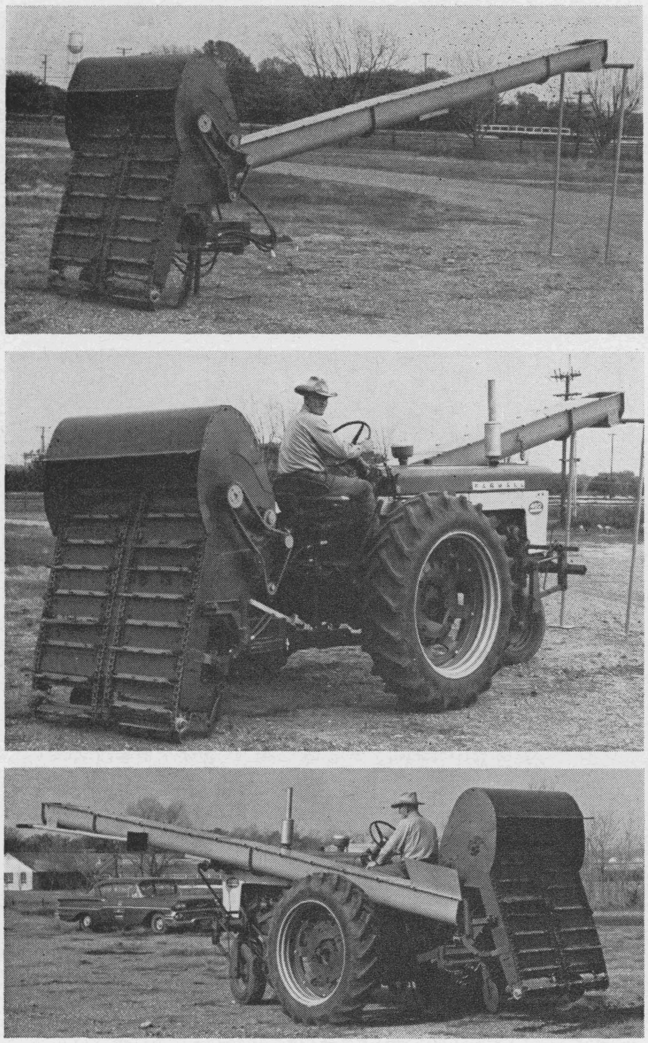


Figure 7. Three views of experimental silo unloader. The unit, with power take-off drive, is mounted on implement coupling beams for fast-hitch attachment to a tractor. Unloader detached from tractor (top); backing tractor into position for attachment of unloader to tractor (center); unloader in transport position (bottom).

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. After contact with the silage is made, the brakes are locked on the tractor. The unloader, mounted on telescoping arms, is then forced into the silage with the tractor hydraulic system. The rate of advance of the unloader into the silage is controlled from the tractor seat by the operator. The upward movement of the combination digger-conveyor against the stack breaks the silage loose as it moves into the stack and conveys the material to a 9-inch diameter cross auger at the top of the unloader. The silage is then deposited into another 9-inch auger which transports it into a truck or trailer at the front of the tractor. Plans, giving details of construction, are available upon request from the Department of Agricultural Engineering, Texas A&M University.

A maximum capacity of 7.3 tons of silage per hour was 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.

A commercial concern has built and tested a machine patterned after the experimental unloader. The width of the digging attachment is about 3 feet wider on the commercial unloader than it is on the experimental machine.. With this increased width, the capacity of the commercial unloader was more than double the capacity of the experimental machine. The same company has built another machine that has several improvements over the original unit.

Figure 8. A commercial unloader, patterned after the experimental machine developed at Texas A&M University (top). The unloader in operation (bottom).

This machine will be used as a prototype for production models.

COSTS OF HARVESTING, STORING AND FEEDING SILAGE

Harvesting and Storing Costs

Comparative costs for harvesting and storing silage in the same size (20 feet wide by 90 feet long) bunker and stack silos are given in Tables 4-6. Investment costs per ton of feedable silage were $7.93 for a bunker silo with a 4-inch reinforced concrete slab and preservative-treated lumber sides and posts; $5.37 for a stack silo with a 4-inch reinforced concrete slab and temporary walls (2 feet high); $6.15 for a stack silo with a 4-inch reinforced concrete slab and without walls; 88 cents for a stack silo on a sand fill and with temporary walls; and 51 cents for a stack silo on a sand fill and without walls. Annual storage costs per ton of feedable silage for these silos were $1.42, $1.78, $2.43, $1.64 and $2.15, respectively.

As shown in Table 6, annual costs per ton for harvesting, filling the silo and storing silage were $4.80 for a bunker silo with a concrete floor and preservative-treated wood walls, compared to $5.40 for a stack silo with a concrete floor and temporary walls and $6.54 for a stack silo with a concrete floor and no walls. The annual costs also were higher for a stack silo on a sand fill than for the bunker. The lower costs for the bunker silo were a result of less labor required for filling, the ability to obtain more uniform and tighter packing and less spoilage loss. Labor costs were less for bunker silos than stack silos, because the silage was easier to pack and less labor was required for filling and sealing the silos.

TABLE 4. ANNUAL STORAGE COSTS FOR STORING SORGHUM SILAGE IN THE SAME SIZE BUNKER AND STACK SILOS[1]

Item	Type of silo				
	Bunker[2]	Stack			
		Concrete slab	Concrete slab	Sand fill	Sand fill
Silo dimensions, feet					
Width	20	20	20	20	20
Length	90	90	90	90	90
Wall height	6	2[3]	No walls	2[3]	No walls
Investment	$1,380	$790	$720	$130	$60
Years of life	25	25	25	5	5
Depth of settled silage, feet	5.5	5.5	5.0	5.5	5.0
Density, lb. per cu. ft.	45	40	35	40	35
Tons of settled silage	183	163	137	163	137
Percent of spoilage	5	10	15	10	15
Tons of feedable silage	174	147	117	147	117
Annual costs, dollars:					
Depreciation	$ 55.20	$ 31.60	$ 28.80	$ 26.00	$ 12.00
Repairs	30.00	10.00	5.00	15.00	10.00
Interest, taxes	41.40	23.70	21.60	3.90	1.80
Plastic film cover[4]	48.00	68.00	68.00	68.00	68.00
Spoilage[5]	72.00	128.00	160.00	128.00	160.00
Total annual cost, dollars	$246.60	$261.30	$283.40	$240.90	$251.80
Cost per ton of feedable silage, dollars:					
Initial investment	$7.93	$ 5.37	$ 6.15	$ 0.88	$ 0.51
Annual	1.42	1.78	2.43	1.64	2.15

[1]Based on data obtained with experimental silos.
[2]Four-inch reinforced concrete floor with preservative-treated lumber sides and posts. Posts set in concrete.
[3]Temporary walls used to form stacks and then removed.
[4]Cost of sawdust covering not included.
[5]Silage valued at $8 per ton.

Feeding Costs

Records were kept on labor and equipment requirements for hand-feeding, self-feeding and mechanically-feeding silage. Hand-feeding methods used were (1) silage loaded into portable feed troughs at the silo and then pulled 600 feet to the feeding areas, and (2) silage loaded into a trailer and pulled by a tractor to three locations at distances ranging from 400 feet to ½ mile from the silo. A commercial silo unloader with a cage-type reel digger head was used

TABLE 5. EQUIPMENT AND LABOR COSTS FOR HARVESTING SORGHUM FORAGE AND FILLING BUNKER AND STACK SILOS OF THE SAME SIZE[1]

Item	Type of silo				
	Bunker[2]	Stack silos			
		Concrete slab	Concrete slab	Sand fill	Sand fill
Silo dimensions, feet					
Width	20	20	20	20	20
Length	90	90	90	90	90
Wall height	6	2[3]	No walls	2[3]	No walls
Silage depth before settling, feet	6	6	5.5	6	5.5
Tons of settled silage	183	163	137	163	137
Tons of feedable silage	174	147	117	147	117
Equipment costs for:					
Harvesting					
Tractor[4]	$28.80	$25.00	$22.50	$25.00	$22.50
Field-chopper[5]	66.70	58.00	52.20	58.00	52.20
Hauling forage to silo[6]	380.00	320.00	288.00	320.00	288.00
Packing silage	26.45	26.45	24.15	26.45	24.15
Total equipment cost	$500.95	$429.45	$386.85	$429.45	$386.85
Labor costs for:[7]					
Harvesting	$23.00	$20.00	$18.00	$20.00	$18.00
Hauling forage to silo[8]					
Filling silo	54.00	70.00	62.00	70.00	62.00
Covering silo[9]	10.00	12.00	14.00	12.00	14.00
Total labor cost	$87.00	$102.00	$94.00	$102.00	$94.00
Total equipment and labor cost	$587.95	$531.45	$480.85	$531.45	$480.85

[1]Based on data obtained with experimental silos.
[2]Four-inch concrete floor with preservative-treated lumber sides and posts. Posts set in concrete.
[3]Temporary walls used to form stack and then removed.
[4]Cost based on $1.25 per hour.
[5]Cost based on $2.90 per hour.
[6]Dump trucks hired with a driver for $4 per hour.
[7]Labor costs based on $1 per hour.
[8]Included in equipment cost for hauling forage to silo.
[9]Does not include cost for applying sawdust cover.

TABLE 6. ANNUAL COSTS FOR HARVESTING SORGHUM FORAGE, FILLING SILOS AND STORING SILAGE IN THE SAME SIZE BUNKER AND STACK SILOS[1]

Item	Type of silo				
		Stack silos			
	Bunker[2]	Concrete slab	Concrete slab	Sand fill	Sand fill
Dimensions of silo, feet					
Width	20	20	20	20	20
Length	90	90	90	90	90
Wall height	6	2[3]	No walls	2[3]	No walls
Depth of settled silage, feet	5.5	5.5	5.0	5.5	5.0
Tons of settled silage	183	163	137	163	137
Tons of feedable silage	174	147	117	147	117
Annual costs for:					
Harvesting forage and filling silo	$587.95	$531.45	$480.85	$531.45	$480.85
Storing silage	246.60	261.30	283.40	240.90	251.80
Total annual cost	$834.55	$792.75	$764.25	$772.35	$732.65
Annual cost per ton of feedable silage:					
Harvesting forage and filling silo	$3.38	$3.62	$4.11	$3.61	$4.11
Storing silage	1.42	1.78	2.43	1.64	2.15
Total	$4.80	$5.40	$6.54	$5.25	$6.26

[1]Based on data obtained with experimental silos.
[2]Four-inch reinforced concrete floor with preservative-treated lumber sides and posts. Posts set in concrete.
[3]Temporary walls used to form stack and then removed.

to remove silage from a bunker silo in the mechanical feeding studies. The unloader was mounted on a tractor and was PTO operated. Spring teeth on the reel dug the ensilage loose. The loose material was caught in a hopper and delivered by an auger to a rubber conveyor belt, which conveyed it to a power forage feeder mounted on a truck. The silage was then transported about 5 miles to feed bunks where it was unloaded mechanically.

As shown in Table 7, labor and equipment costs for feeding one animal unit per day were 11.7 and 13.0 cents, respectively, for the hand-feeding methods; 1.5 cents for self-feeding; and 9.0 cents for mechanical feeding. Based on a 30-day feeding period, comparative costs per animal unit were $3.51, $3.90, 45 cents and $2.70, respectively.

TABLE 7. COMPARATIVE COSTS OF DIFFERENT METHODS OF FEEDING SILAGE FROM HORIZONTAL SILOS

Item	Hand feeding[1]		Self feeding	Mechanical feeding
	No. 1	No. 2		
Number of animal units fed	41[2]	70[3]	34[4]	173[5]
Feeding space per animal unit, inches			5.3	
Number of days fed	42	14	37	67
Distance from silo to feeding area, miles	0.11	See note		5
Pounds of silage consumed per animal unit per day		49.2	56.1	55.5
Labor requirements:				
Total man-hours	91.0	42.0	16.8	423.5
Man-minutes per animal unit per day	3.1	3.2	0.80	2.2
Equipment requirements:				
Total hours of operation				
Tractor	91.0	22.0		45.0
Trailer		22.0		
Silage unloader				45.0
Power forage feeder				212.0
Minutes per animal unit per day				
Tractor	3.1	2.3		0.23
Trailer		2.3		
Silage unloader				0.23
Power forage feeder				1.10
Cost per animal unit per day, cents:				
Labor (based on $1 per hour)	5.2	5.3	1.3	3.7
Equipment:				
Tractor (based on $1.25 per hour)	6.5	4.8		0.5
Trailer (based on 75 cents per hour)				
Silage unloader (based on $2.50 per hour)				1.0
Power forage feeder (based on $2 per hour)				3.7
Silage wasted (valued at $8 per ton)			0.2	0.1
Total cost	11.7	13.0	1.5	9.0[6]

[1]Hand feeding methods were as follows: No. 1—silage loaded by hand into portable feed troughs at the silo and then pulled 600 feet to feeding location. No. 2—silage loaded by hand into a trailer at silo and then pulled to three locations at distances ranging from 400 feet to 0.5 mile from silo, where it was unloaded by hand into feed troughs.
[2]Forty-one Holstein cows.
[3]Sixty-four beef cows with 26 nursing calves. Each calf considered as 0.25 animal unit.
[4]Twenty-eight beef cows with 24 nursing calves. Each calf considered as 0.25 animal unit.
[5]One hundred and forty-one cows and 126 calves. Each calf considered as 0.25 animal unit.
[6]Silage was hauled 5 miles to feed bunks compared to a maximum distance of 0.5 mile for the hand feeding methods. Based on a hauling distance of 0.5 mile, this cost would be approximately 5.8 cents per animal unit per day.

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Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of the parts of Texas A&M University.

OPERATION

IN THE MAIN STATION, with headquarters at College Station, are 13 subject-matter departments, 3 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 20 substations and 10 field laboratories. In addition, there are 13 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

ORGANIZATION

THE TEXAS STATION is conducting about 450 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasites
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural products
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress

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