SELF-FEEDING SILAGE TO BEEF CATTLE FROM HORIZONTAL SILOS

A Study of 49 Farms

By R. N. Van Arsdall

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SELF-FEEDING SILAGE TO BEEF CATTLE FROM HORIZONTAL SILOS

By R. N. Van Arsdall[1]

Storing silage in trenches, pits, and stacks is as old as the practice of making silage, but adapting this method to modern systems of farming is a recent development. Illinois farmers did not show appreciable interest in horizontal silos until the late 1940's, when emphasis was placed on more grasses and legumes in the rotation, resulting in a need for an inexpensive method of storing grass silage.

Trench silos first appeared in numbers on feeder cattle farms about 1950. Ordinarily they were limited to areas in which the terrain was suited to the construction of trenches below ground level, and silos were seldom convenient to the feedlot. Self-feeding was not practiced.

Recent developments of wood and concrete bunker silos built at ground level have encouraged the spread of horizontal silos throughout the feeder-cattle and dairy areas of Illinois. This type of silo can be constructed adjacent to the feedlot as an integral part of a drylot feeding system.

Most of the bunker silos were used originally for storage only; the silage was removed by hand or with mechanical equipment and hauled to the cattle. Many farmers later converted their facilities to self-feeding of silage direct from the silo. Others have planned and built horizontal silos specifically for self-feeding. Most of these self-feeding programs have been successful, but inexperience and the apparent simplicity of self-feeding have caused difficulties with results ranging from the need to add some labor to the failure of the feeding program.

PURPOSE AND METHOD OF STUDY

The purpose of this study was to collect and interpret data on the experiences of Illinois farmers as a basis for detailed recommendations for the operation of self-feeding silage to beef cattle from horizontal silos.

Forty-nine farmers using horizontal silos to self-feed silage to beef cattle were surveyed during the spring of 1957. Data were obtained for 1956-57 on the following: (1) type of cattle, feeding

[1] Agricultural Economist, Farm Economics Research Division, Agricultural Research Service, United States Department of Agriculture.

programs, and physical facilities; (2) construction and costs of horizontal silos; (3) practices involved in the two major operations — making and keeping silage, and self-feeding silage to cattle; (4) capital and labor requirements of these two operations; and (5) problems encountered.

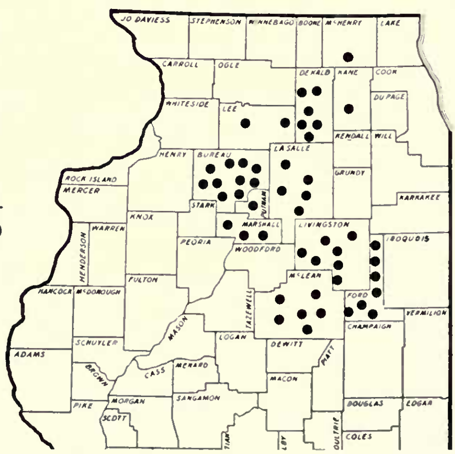
Observations and photographic records were made of all silage-feeding operations active at the time the farms were visited. Sale weights of the cattle that were on the self-feeding program were obtained from the farmers by mail questionnaires in the fall of 1957. Visits were made to selected farms during the winter of 1957 to examine the effects and condition of synthetic covers that had been used on silos the previous summer. Additional information on problems of freezing of silage and drifting snow during the exceptionally cold winter of 1958 was obtained by a mail questionnaire.

CHARACTERISTICS OF THE STUDY FARMS

General farm information

Most of the farms included in the study were in the north-central section of Illinois (Fig. 1). They ranged in size from 120 to 900 acres and averaged 290 acres. The predominant crop rotation was two years corn, one year small grain, and one year meadow. Oats were the chief small grain and alfalfa-brome was the usual meadow mixture. Soybeans were of little importance.

Feeder cattle and hogs, the chief livestock enterprises, comprised



Location of the 49 farms included in the study. (Fig. 1)

95 percent of the total animal units.[1] The ratio was nearly two animal units of feeder cattle to one of hogs. Small numbers of sheep, feeder lambs, dairy cows, and laying hens were present on a few farms. Total animal units averaged 161 per farm, with an average density of 58 animal units per 100 acres of land.

Operation of the farms was evenly divided between tenant-operators and owner-operators. Only seven farmers had self-fed silage for more than three years. Thirty-three farmers had two or three years of experience, and nine men were in their first year of operation. All farmers included in the study had fed beef cattle by other methods before they turned to self-feeding of silage.

Cattle and feeding program

More than 4,700 feeder cattle were self-fed silage from horizontal silos on the 49 farms included in the study. Three-fourths of the farmers had one lot of cattle on the self-feeding program during 1956-57, and one-fourth had two or more lots.

The cattle were about evenly divided between calves and yearlings, assuming 500 pounds as the dividing point between the two classes. Seventy percent were graded good-to-choice or better. Seventy-two percent were of the Hereford breed, 8 percent were Angus, and 20 percent were mixed breeds.

Ninety percent of the cattle were purchased between August and November, but some purchases were made each month from June to the following March.

On most farms the self-feeding program began in November or December, and ended between March and May. The programs usually lasted four to six months.

Except for the method of feeding silage, the feeding program on the farms studied did not differ from that on other farms. Calves were kept for about 12 months and yearlings were on feed for about 9 months. Steers were usually held longer than heifers. Approximately the same number of cattle were fed grass silage as were fed corn silage, with no apparent relation between the grade of cattle and the kind of silage fed them.

On December 1, the usual date for beginning the self-feeding program, more than half the cattle weighed between 500 and 700 pounds. About 30 percent weighed less than 500 pounds.

From the date of purchase until the date of sale, the cattle gained

[1] One animal unit equals one mature cow, five mature sheep, 100 hens, one and one-third feeder cattle, or five hogs.

an average of 1.7 pounds a day, with a few lots gaining more than 2 pounds a day. The average rate of gain was about the same as that from other feeding methods,[1] even though it was biased downward because of the following: shrinkage was encountered twice because total gains were computed from purchase weights at the western shipping point and sale weights at market; sick or injured animals that made little or no gain during the feeding period were included in the rate-of-gain calculations; and the initial weight of cattle that died during the feeding period was deducted from the net gain of the entire drove. No deaths were traceable to any part of the self-feeding operation.

Because calves were kept on feed longer than yearlings, the sale weights of the cattle were about the same regardless of whether they had been calves or yearlings when purchased. The sale weights for steers averaged 1,100 pounds and, for heifers, 900 pounds.

Facilities

Barns. General-purpose barns with mow storage for hay were usual on the farms studied. Barns built within the last few years were of the one-story, open-front type with storage for hay and bedding at ground level.

Shelter space, exclusive of the area used for storage of hay and bedding, ranged from 20 to 100 square feet per animal, based on the average number of cattle housed during the 1956-57 feeding period. An average of 43 square feet per animal was provided, but the median space allotment was 34 square feet per head, which approximates the usual recommendation.[2]

On nearly three-fourths of the farms the floors of shelter barns were paved. Most of the farmers who ran hogs with the cattle considered paved floors essential.

Lot areas. All cattle lots were paved on 40 percent of the farms. Another 40 percent had some paved and some dirt lots, partly by design and partly because paving had not been completed. The remaining 20 percent had no paving.

Paved lot space per animal, based on the 1956-57 stocking rate, ranged from 20 to 478 square feet on those farms on which all lot

[1] *Twentieth Annual Report of Feeder Cattle,* College of Agriculture, University of Illinois, December, 1958, AE3356 (mimeo).

[2] Feeder cattle should have 20 to 33 square feet of shed space per head, depending on the size of the animals. *Planning the Farm Business,* College of Agriculture, University of Illinois, 1947.

areas were paved. The average of 100 square feet and the median of 77 square feet were considerably greater than the recommended 30 to 40 square feet per head.[1]

On farms with part or all of the lot area unpaved, the space per animal was greater than on farms with all areas paved. For the most part, lot space per animal ranged from 200 to 400 square feet, but it was much higher on the few farms on which several acres were open to the cattle.

Building a horizontal silo as part of the feedlot provided additional paved space for the cattle — 20 to 25 square feet per animal by the end of the silage-feeding period.

Equipment. The equipment for grinding corn and feeding hay was essentially the same as that on farms employing the usual beef-feeding methods. Bunk space was not reduced on the farms in the study.

Farmers fed concentrates by hand to relatively large droves. This was because the self-feeding of silage reduced by about three-fourths the amount of feed that had to be transported, thus reducing also the need for a mechanical distribution system.

All farms were equipped with tractor-mounted loaders for handling manure. Some farmers also used scrapers mounted on the rear of the tractor to clean the lot and floor of the silo. Manure spreaders of medium to large capacities were available on all farms.

HORIZONTAL SILOS

Reasons for building

Four-fifths of the farmers listed the lower initial cost as a primary reason for building a horizontal rather than an upright silo. Another reason, named by two-thirds of the operators, was the reduction in labor achieved by putting the cattle on self-feeding. Only a few farmers thought that it was easier to fill a horizontal silo than an upright silo. The farmers admitted that losses from spoilage were greater in a horizontal silo, but considered them to be more than offset by savings in labor and other costs.

Type and age

Nearly all of the horizontal silos on the study farms were of the bunker type and of relatively recent origin. Three were built before 1954, 40 in 1954 and 1955, and 6 in 1956.

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[1] *Planning the Farm Business,* College of Agriculture, University of Illinois, 1947.

Materials and methods of construction

The side walls of 23 silos were made of two-inch tongue-and-groove lumber that had been pressure treated with a preservative. Fourteen silos had walls of poured concrete or preformed concrete slabs. Other materials used for side walls included concrete blocks, railroad ties, and snow fence. Three operators merely piled the silage on a concrete slab and used an electric wire to keep the cattle away.

A sealing material, generally tar, was applied to the joints of the side walls in only 11 silos.

Wooden posts treated with a preservative were used for the wall framing of 29 silos. These posts were usually placed 4 feet on center, although in some silos, the spacing was as great as 8 feet. The top diameter was usually at least 6 inches. Other wall supports used were concrete pilasters and banks of earths.

The walls or supporting members of the walls were firmly anchored to a concrete footing in most of the silos. Frequently ⅜-inch iron tie rods were placed around the base of the posts of wood-walled silos and allowed to extend into the concrete floor for additional reinforcement.

Most farmers considered paved silo floors essential for self-feeding. In 43 silos the entire floor was paved, with all but one of them having paved approaches or the open end of the silo joining a paved feedlot.

In this silo, the preformed concrete-slab walls are sloped and supported by a bank of earth. In addition to supporting the walls, the earth bank helps prevent freezing of the silage during very cold weather. (Fig. 2)

Table 1. — Initial Costs per Ton of Capacity of Horizontal Silos Constructed by Farm or Contracted Labor, 46 Illinois Farms, 1954-1956[a]

	Wood-walled silos[b]		Concrete-walled silos[c]		Other silos[d]
	Contract	Farm	Contract	Farm	Farm
Number of silos	8	12	5	11	10
Capacity, tons[e]					
Range	104-325	104-357	101-210	121-382	108-433
Average	194	245	142	189	197
Cost per ton[f]					
Range	$ 3.78-10.81	$3.28-7.71	$ 6.69-11.97	$ 2.96-11.84	$ .97-7.58
Average	7.00	5.18	9.45	6.95	3.38

[a] No adjustments were made for changes in price level during this period.
[b] Above-ground silos constructed of treated posts and 2-inch plank for the side walls. Floors are of concrete.
[c] Side walls constructed of concrete block, preformed concrete slabs supported by earth banks or concrete pilasters, or poured concrete. Floors are of concrete.
[d] Constructed of miscellaneous materials not included in the first two classifications.
[e] Based on a silage weight of 35 pounds per cubic foot.
[f] Unpaid labor used in construction was charged at $1 per hour.

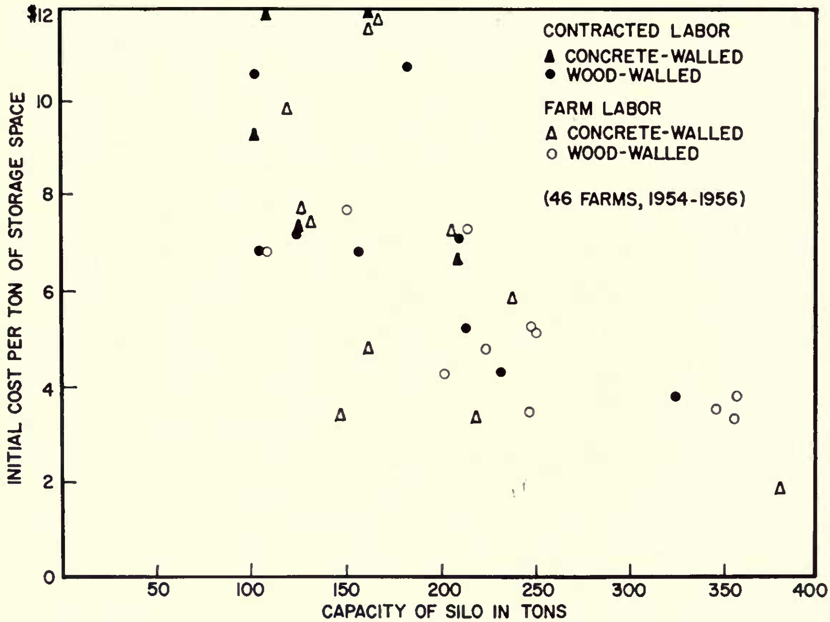
On six farms such materials as limestone, crushed rock, and railroad ties were used for the floors, and the approaches were not paved.

Most concrete floors were 4 to 5 inches thick, and half of them were reinforced with welded wire mesh.

Paved floors were sloped for drainage. Usually a single slope was made toward the open end of the silo, but a few farmers had sloped the floor from the center of the silo toward both ends so that the cattle could feed from both ends. Nearly half of the silos had floors with a slope of 1 percent; only 5 silo floors sloped as much as 3 percent.

Slope of the side walls varied considerably, depending upon the kind of wall material and the belief of the operator as to the effect of slope on the ease of packing the silage and the extent of spoilage. Some poured-concrete and concrete-block walls were built vertically. Wooden walls were sloped 5 to 10 percent; the common rule was 1 inch of slope per foot of rise. If the side walls were supported by a bank of earth, as was often the case with preformed concrete slabs, the slope of the walls usually exceeded 10 percent.

Half of the farmers had constructed filling ramps at one end of the silo. These ramps consisted of a bank of earth that rose gradually to a height of about 4 feet as it approached the end of the silo. A concrete or wooden abutment was often used to square the end of the



In general, the larger the volume of storage space, the lower the initial cost per ton. If spoilage were added to storage costs, the advantage of larger silos would be more apparent, since the percentage of spoilage loss is greatest in small silos, particularly those that are shallow. (Fig. 3)

ramp next to the silo. These ramps eased the job of filling the silo and reduced spoilage at the end of the silo.

Size and capacity

The silos on the 49 study farms ranged in size from 5 to 12 feet deep, 16 to 48 feet wide, and 40 to 150 feet long. A typical size of silo was 6 x 24 x 72 feet.

A conservative estimate placed the weight of silage in a horizontal silo at 35 pounds per cubic foot, which is the approximate weight of silage in a tower silo at depths of 5 to 7 feet.[1] On this basis, the capacities of the silos ranged from 101 to 662 tons, and approximated 181 tons for the typical silo. Four-fifths of the farmers said they filled their silos to capacity in 1956.

[1] J. B. Shepherd and T. E. Woodward, *Estimating the Quantity of Settled Corn Silage in a Silo,* USDA Circular 603, April, 1941, p. 9.

Initial cost

About three-fourths of the horizontal silos were built by labor available on the farm. They cost about $2 less per ton of capacity than silos built on a contract basis (Table 1); the actual cash outlay was nearly $3 less per ton of capacity for farm-constructed silos.

Silos built of concrete cost about $2 more per ton of capacity than wood-walled silos, whether constructed by farm labor or on a contract basis. Costs averaged $5 to $7 per ton of capacity in the wood-walled silos and $7 to $9 in the all-concrete silos, depending upon the method of construction. Individual silos varied considerably from the average, according to the price and quality of materials, distance in hauling bulk materials, extent of site preparation, installation of ramp, and size of silo.

Initial costs per ton can be lowered if the volume of storage space is increased by increasing the width, height, or both. The data in Fig. 3 partly indicate the effect of volume on unit costs.

Depreciation

The silos on the study farms were not old enough to permit observation of structural depreciation. Permanent-type silos showed little or no evidence of deterioration after three years of use, if basically sound plans of construction had been followed. All concrete floors and side walls were in good condition. Plank side walls of four silos for which low-quality materials had been used or which were inadequately supported were considerably out of alignment. The condition of silos built of such miscellaneous materials as railroad ties, snow fence, untreated lumber, limestone, and earth varied greatly even after only one year of use.

Farmers' estimates of the useful life of silos made of treated lumber

Table 2. — Farmers' Estimates of Useful Life of Their Horizontal Silos, 46 Illinois Farmers, 1957[a]

	Wood-walled silos	Concrete-walled silos	Other silos
Number of silos	19	16	11
Estimated life, years			
Range	6–25	15–50	3–50
Average	16.2	28.9	18.2
Standard deviation	4.7	10.1	12.6

[a] Most of the silos were constructed from 1954 to 1956.

and concrete averaged 16 years (Table 2). The average for silos built entirely of concrete was 29 years, but the variation among individual estimates was greater than for wood-walled silos. The estimated life of the silos in the miscellaneous group ranged from 3 to 50 years.

Except for reinforcing, which was necessary in a few silos to strengthen the original construction of the side walls, no annual expenditures had been made for maintenance and repairs. Farmers had no adequate basis for opinions as to probable expenditures for maintenance and repairs, but they believed that these expenditures would be low.

MAKING AND KEEPING SILAGE

Most of the practices involved in making and keeping silage have two basic purposes: to provide nutritive and palatable silage, and to prevent spoilage of the silage.

Providing nutritive and palatable silage depends on such practices as using good-quality forage and harvesting at the right stage of maturity. Since these practices do not vary with the type of silo used, data were not collected for this part of the silage-handling operation. Neither were measurements made of losses from fermentation and seepage, two additional problems encountered in storing silage. Losses from these processes are not greatly affected by the type of silo.[1]

Preventing spoilage

Horizontal silos are subject to greater losses from spoilage than are upright silos of equal capacity. This is because horizontal silos have a relatively large exposed surface; the larger the exposed area in relation to the depth of the silo, the greater the loss from spoilage.

Estimates of spoilage in the silos on the study farms were based on measurements of the cubic feet of spoiled silage on the top, sides, and ends of the silo. Silage was estimated to weigh 20 pounds per cubic foot on the top of the silo and 30 pounds along the side walls.[2] Losses at the ends of the silo were estimated from the number of spreader loads removed at the beginning and the end of the feeding period.

Spoilage in all silos averaged 9.1 percent of the total weight of

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[1] J. B. Shepherd, C. H. Gordon, and L. F. Campbell, *Developments and Problems in Making Grass Silage*, USDA, Dairy Industry Bureau BDI-Inf. 149, May, 1953, p. 11.

[2] The weight of a cubic foot of silage increases with the depth of the silage. Shepherd and Woodward, *op. cit.*, p. 5.

Table 3. — Farmers' Recommendations as to Minimum Width of a Horizontal Silo for Effective Storage of Silage, 46 Illinois Farmers, 1957

Width	Farmers recommending specified minimum silo widths	
feet	*no.*	*perct.*
Below 12	4	9
12.0–16.9	14	30
17.0–21.9[a]	21	46
22.0–26.9	5	11
27.0 and above	2	4
Total	46	100
	feet	
Mean	18.0	
Standard deviation	5.2	

[a] Eighteen farmers specified 20 feet as the minimum width.

forages ensiled.[1] Losses in individual silos ranged from 2.3 to 28.8 percent of the total. In the 25 percent of the silos with the least spoilage, losses from spoilage averaged 3.8 percent; in the 25 percent with the most spoilage, spoilage losses averaged 14.4 percent.

Top spoilage averaged more than half the total spoilage, with a range of 4 to 96 percent of total spoilage losses on individual farms. Losses along the side walls averaged 18 percent of the losses, and end spoilage accounted for 26 percent. An increase in spoilage in these areas resulted in a lower proportion of loss from the top of the silo, but total losses were usually greater.

Improper packing was the major cause of spoilage along the side walls. Since only one wheel of the packing tractor can run along the side walls, the silage in the center of the silo packs more firmly than that along the side walls; differences in amount of settling then result in a break in the silage along each wall. This trouble can be avoided by thoroughly packing the sides as well as the center.

Improper packing along the sides also resulted from crowning the stack of silage during filling. The crown usually caused the tractor wheels to tilt and resulted in difficulty in packing along the side walls.

No relation was observed between the slope of the side walls and ease of packing or amount of side spoilage.

Width of silo. Many of the spoilage losses due to improper packing occurred in narrow silos. Silage cannot be packed adequately if the

[1] Under optimum conditions, minimum loss of dry matter in a trench silo is estimated to be 8 percent from surface spoilage, 9 percent from fermentation, and 3 percent from seepage. Shepherd, Gordon, and Campbell, *op. cit.*, p. 10.

silo's width is less than twice the span of the wheels of the packing tractor. The farmers in the study reported that they considered a minimum width to be one which would permit free passage of the packing tractor and the hauling vehicle on the silo at the same time. Forty percent of the farmers specified 20 feet as the minimum width (Table 3). Most of the cattle feeders believed that unless the feeding operation is large enough to justify a horizontal silo at least 20 feet wide, forages should be stored in another type of silo or by another method. The more experienced operators preferred even wider silos.

A wider silo will not reduce the amount of spoilage along the sides, but the proportion of side spoilage in relation to the volume of the silo will be lower.

These opinions concerning width of silos are related only to the processes of making silage and preventing spoilage. Width must also be considered in relation to the number of cattle to be self-fed (see page 21).

Depth of silage in a horizontal silo is inversely related to the proportion of spoilage. But if the silage is too deep for complete self-feeding, extra labor may be required. More than half the farmers recommended a maximum depth of 6 to 7 feet (Table 4); they believed that if the depth exceeded 7 feet, the extra labor needed in the feeding operation would more than offset the advantage gained through reduced spoilage. Three-fourths of the farmers believed that the minimum depth should be 4 to 6 feet if surface spoilage were to be kept from becoming a prohibitive cost.

Table 4. — Farmers' Recommendations as to Minimum and Maximum Depths of Settled Silage in a Horizontal Silo for Use in a Self-Feeding Program, 47 Illinois Farmers, 1957

Depth	Farmers recommending specified silage depths as:			
	Minimum		Maximum	
feet	*no.*	*perct.*	*no.*	*perct.*
Below 4.0	9	20	0	0
4.0	12	26	0	0
5.0	14	30	9	19
6.0	10	22	15	32
7.0	0	0	11	23
8.0 and above	1	2	12	26
Total	46	100	47	100
	feet		*feet*	
Mean	4.8		6.9	
Standard deviation	1.1		1.7	

Thus the combined experiences of nearly 50 cattle feeders indicate that a horizontal silo should not be used unless the drove is large enough to justify a silo at least 20 feet wide containing 5 to 7 feet of settled silage.

Quantity of silage stored in a horizontal silo affects the percentage of spoilage loss. Low-capacity structures present a greater exposed surface area in relation to volume than do large silos. On the farms studied most of the silos were comparatively large. The average quantity of silage stored per silo was 232 tons, with a range of 60 to 500 tons. About one-fourth of the variation in the percentage spoiled was associated with differences in quantity of silage. Within the observed range of 60 to 500 tons, the percentage of spoilage, assuming average harvesting and storing methods, decreased by one percentage point for each additional 50 tons of silage. Differences among the average spoilage losses in corn, grass-legume, and small-grain silage were not significant.

Cracks in the walls of silos caused small quantities of silage to spoil. A few farmers attempted to seal wooden walls with heavy paper, but found the practice to be of little value. The paper was difficult to keep in place during filling and was easily torn when the tractor wheels came too close to the sides. Tar was the most satisfactory method of applying a permanent seal to the cracks in wooden walls and preformed concrete slabs.

Surface covers. Most cattle feeders would probably use surface covers on their horizontal silos if an effective and economical material for such covers were available. During the 1956-57 feeding period only 12 of the 49 farmers used surface covers. Of these, 6 used polyethylene sheets and 6 used low-value forages.

Polyethylene covers. Four farmers used clear polyethylene covers. All deteriorated within a few months and did little to reduce spoilage. Two farmers used black polyethylene covers. These were successful in reducing spoilage and resisting decomposition, but the operators had difficulty in preventing wind damage. One of them held the cover in place with a layer of chopped forage, but the forage froze and, in removing the frozen material, he destroyed the cover. The other operator used limestone around the edges and posts, pipes, hay, and miscellaneous materials in the center. Mice nesting in the hay cut holes in the cover.

If these problems of mechanical difficulty could be overcome, permitting surface covers to last longer, significant savings from spoilage

Table 5. — The Practicality of Using a Polyethylene Cover to Prevent Spoilage on the Surface of a Horizontal Silo as Related to the Cost and Life of the Cover, and the Value of the Silage[a]

Initial cost of cover per 100 square feet	The gain each year between the cost of 100 square feet of cover[b] and the value of silage saved[c]											
	When the cover lasts 1 year and the value of a ton of silage is:				When the cover lasts 2 years and the value of a ton of silage is:				When the cover lasts 3 years and the value of a ton of silage is:			
	$6	$8	$10	$12	$6	$8	$10	$12	$6	$8	$10	$12
$2.00	−$.05	$ .61	$1.25	$1.95	$ .75	$1.41	$2.05	$2.75	$1.08	$1.74	$2.38	$3.08
$2.50	− .56	.10	.74	1.44	.44	1.10	1.74	2.44	.86	1.52	2.16	2.86
$3.00	−1.08	− .42	.22	.92	.12	.78	1.42	2.12	.62	1.28	1.92	2.62
$3.50	−1.59	− .93	−.29	.41	−.19	.47	1.11	1.81	.39	1.05	1.69	2.39
$4.00	−2.10	−1.44	−.80	−.10	−.50	.16	.80	1.50	.17	.83	1.47	2.17

[a] It is assumed that the alternative of using a high-moisture low-value forage for a surface cover is not available.

[b] Charges for the use of the cover include the proportion of the initial cost used in each year, interest at the rate of 5 percent of the average value of the cover during the period of use, and annual repairs at 10 percent of the initial cost of the cover when it is used for more than a year. No charge is made for the weights used to hold the cover in place. The labor for handling the cover is assumed to equal the labor for removing spoilage from a silo that has not been covered.

[c] The silage saved is assumed to be 4 inches deep, weighing 20 pounds per cubic foot. The possible benefits of the cover's protecting the silage from rain were not evaluated.

losses could be effected, particularly if the silage were of high value (Table 5). On most farms, the reduction in losses could at least equal the cost of the cover. If the silage were not packed properly, therefore being subject to excessive spoilage, a surface cover could be of even greater benefit.

Low-value forages. The six farmers who used 4 to 5 inches of low-value forage as a surface cover found it effective. The material was obtained from grass waterways or the edges of fields, or it was corn stover from which the ears had been snapped. These materials spoiled and had to be removed from the silo, but the labor requirements differed little from those of managing a plastic cover. The costs of this method were the labor and equipment expenses for harvesting and applying the forages.

Conditioners.[1] Farmers were not convinced that conditioners were necessary or even beneficial in the making of good silage.[2] No conditioners were used with corn silage. Nine farmers used a conditioner with alfalfa-brome or alfalfa-timothy mixtures. Observations indicated that the palatability of grass-legume silage probably would have been increased by the use of conditioners on some farms where the forage contained too much moisture.

Molasses pellets were used by 6 of the 9 farmers who used conditioners. These pellets or other dry material were either scattered over the silo with a shovel or spread over the bottom of the forage wagon. Neither method was completely satisfactory. Farmers believed that the materials remained in layers and did not permeate the mass of silage even after several months of storage. One operator attached a hoppered bin to the packing tractor and scattered a small amount of conditioner over the surface of the silo whenever the tractor was in motion. This appeared to be a satisfactory method.

Labor and equipment

Harvesting and storing corn or a forage crop in a horizontal silo requires a large amount of labor and equipment for a short period of time. Most of the farmers surveyed completed harvest in 3 to 4 days. For capacity operation 4 or 5 men were needed — 1 to operate a field forage harvester, 2 or 3 with trucks or tractor equipment to haul forage to the silo, 1 to operate a packing tractor on the silo, and often

[1] Sometimes called preservatives.

[2] Silage conditioners have not been recommended for use in horizontal silos that are properly filled. Shepherd, Gordon, and Campbell, *op. cit.,* p. 3.

Table 6. — Man-Hours Used in Harvesting and Storing Forages in Horizontal Silos, 47 Illinois Farms, 1956

	Grass silage (30 farms)[a]		Corn silage (17 farms)	
	Per acre	Per ton	Per acre	Per ton
All farms				
Range	1.8–7.0	.3–1.4	2.5–14.0	.1–1.1
Median	4.3	.7	6.2	.5
Average	4.1	.7	6.9	.5
Standard deviation	1.4	.3	3.1	.2
One-third most efficient farms[b]				
Median	2.3	.4	3.5	.3
Average	2.3	.4	3.4	.3
One-third least efficient farms[b]				
Median	5.7	1.0	10.0	.6
Average	5.7	1.0	10.4	.7

[a] Includes six farms with small-grain silage.
[b] Farms are classified on the basis of man-hours used per acre or per ton of silage. The most (or least) efficient farms with respect to inputs per acre were not necessarily the most (or least) efficient with respect to inputs per ton.

another at the silo to help unload and level the forage. Sharing of equipment and labor among neighbors was common. Custom harvesting was seldom relied upon because of the short time during which the crop was at the optimum stage of maturity for making into silage.

Labor inputs averaged 6.9 hours per acre for harvesting and storing corn silage, and 4.1 hours for grass silage (Table 6). In terms of hours per ton, corn silage required 0.5 hour and grass silage required

Table 7. — Tractor-Hours Used in Harvesting and Storing Forages in Horizontal Silos, 47 Illinois Farms, 1956

	Grass silage (30 farms)[a]		Corn silage (17 farms)	
	Per acre	Per ton	Per acre	Per ton
All farms				
Range	1.7–5.7	.2–1.1	2.5–12.0	.1–1.1
Median	3.5	.6	6.2	.4
Average	3.5	.6	6.0	.4
Standard deviation	1.1	.3	2.7	.2
One-third most efficient farms[b]				
Median	2.0	.4	2.8	.2
Average	2.1	.3	3.0	.2
One-third least efficient farms[b]				
Median	4.4	.9	8.0	.6
Average	4.5	.9	8.6	.6

[a] Includes six farms with small-grain silage.
[b] Farms are classified on the basis of man-hours used per acre or per ton of silage. The most (or least) efficient farms with respect to inputs per acre were not necessarily the most (or least) efficient with respect to inputs per ton.

Table 8. — Relation of Facilities and Methods Used to Efficiency in Harvesting and Storing Silage in Horizontal Silos, 49 Illinois Farms, 1956

Kind of silage and level of efficiency	Workers in crew	Hours per man per day	Hauling vehicles	Self-unloading wagons	Tractors	Tractors per man	Length of season	Silage packed after harvest	Yield per acre
	no.	*no.*	*no.*	*perct. of farmers*	*no.*	*no.*	*days*	*days*	*tons*
Grass silage, all farms	4.6	8.8	2.2	48	3.6	.83	3.3	4.2	6.2
Rating based on man hours per acre									
Most efficient one-third	4.2	7.8	2.2	37	3.7	.92	2.9	4.7	6.0
Least efficient one-third	5.2	8.8	2.3	67	3.9	.79	3.9	4.1	6.7
Rating based on man hours per ton									
Most efficient one-third	4.2	8.3	2.2	44	3.6	.91	2.7	4.8	8.0
Least efficient one-third	5.1	9.3	2.2	64	3.4	.82	4.2	4.4	5.2
Corn silage, all farms	4.5	9.4	2.2	29	3.4	.79	3.3	2.6	14.4
Rating based on man hours per acre									
Most efficient one-third	4.3	9.0	2.2	40	3.4	.82	2.6	1.4	12.0
Least efficient one-third	4.8	9.4	2.3	17	3.2	.83	4.8	2.3	15.0
Rating based on man hours per ton									
Most efficient one-third	3.8	9.5	2.0	50	3.0	.85	2.5	2.0	16.6
Least efficient one-third	4.6	9.6	2.1	14	3.6	.80	4.0	2.3	12.7

0.7 hour. The labor per ton was larger for grass silage because of its lower average yield (6.2 tons per acre) as compared with that of corn (14.4 tons per acre). Tractor-hours made up 80 to 90 percent of the man-hours used in the harvesting of corn and grass silage (Table 7).

Labor inputs for making silage varied considerably among farms. Farmers with the most efficient combinations of facilities and methods used less than half the man- and tractor-time to handle an acre or a ton of forage than was used on the farms of lowest efficiency (Tables 6 and 7). Among the factors responsible for the variations in hours of labor and tractor inputs were the following: size of crew, yields, length of season, and efficiency of self-unloading wagons (Table 8). Distance from the field to the silo was probably another important factor, but data on it were not available.

Most important factors

According to the 49 farmers, the following factors are the most important ones in making and keeping silage:

Factors of major importance	*Number of farmers reporting*
Thorough packing	45
Harvesting at right stage of maturity	35
Chopping forage as short as possible	10
Spreading forage evenly over silo before packing	8
Covering surface of silo	4
Using forage of good quality	3
Filling silo rapidly	2
Using a conditioner	1

Expected changes

Many farmers were considering one or more possibilities for doing a better job of handling silage. Nearly half planned to try a black polyethylene cover. A few were going to use low-value forages as a surface cover. Only three operators indicated that they would change their packing operations, but most should become more proficient with experience. There was considerable dissatisfaction with the equipment used to haul forages to the silo, because of the difficulty of getting onto the pile of silage and spreading the silage evenly. Other changes being considered by some of the farmers were: harvesting the crop earlier, using a forage that will pack more easily, using a conditioner, sealing the side walls, and using a different method for holding the polyethylene cover in place. Sixteen farmers indicated that they would make no change in their silage-handling operation.

SELF-FEEDING SILAGE[1]

As pointed out earlier, reduction in labor was one of the primary reasons given by the farmers for putting cattle on self-feeding. To maintain the advantage of low labor requirements, cattle feeders must provide for maximum consumption by the cattle and minimum waste of silage, with a minimum of labor and other costs. Two things which greatly influence consumption by cattle and waste of silage are the width of the silo and the type of feeding gate. The depth of silage influences the rate at which silage can be used horizontally, but it is a minor consideration in the management of self-feeding.

Width of silo

Besides its relationship to the silage-handling operation (page 13), the width of a horizontal silo must be considered in relation to the number of cattle to be self-fed. If the silo is too narrow, crowding of cattle may result in inadequate consumption of feed, possible injury to the animals, damage to the feeding gate, and, if the cattle break through the gate onto the silo, loss of silage. If the silo is too wide, the cattle may not be able to eat the silage rapidly enough to keep it from freezing in cold weather, and from losing palatability and spoiling in warm weather.

Space per animal. On the study farms, during the 1956-57 feeding period, the feeding space per animal ranged from 2 to 9 inches, averaging 4.1 inches (Table 9). These space allotments, however, were not necessarily the optimum allotments. Factors other than size of silo often determined the number of cattle on hand in 1956-57.

The average space per animal for the largest drove ever self-fed on each of the farms was 3.7 inches, but 3.0 inches was the more typical allotment (Table 9). Of 29 farmers who provided 2 to 3 inches, 9 reported evidence of crowding and 20 reported complete success. These data indicate that cattle had adequate feeding space if at least 3 inches were provided per animal and that a space allotment of 2 to 3 inches was generally adequate, although there was a possibility of crowding the cattle.

On about half of the farms self-feeding continued during the warmer months of May and June. On some, the number of cattle was considerably reduced, since some of the cattle had been marketed

[1] Records of the self-feeding operation are based for the most part on 46 farms. For various reasons, the data covering this operation were not available for 3 of the 49 study farms.

earlier. The average space allowance on the farms that employed self-feeding during the warm months was nearly 5.0 inches per animal (Table 9). One operator, who allowed 8.5 inches per animal in warm weather reported darkening of the silage but no apparent loss of palatability. No other difficulties were reported because of warm weather.

On some of the farms with low stocking rates during the winter months there were reports of freezing or partial spoilage along the face of the silo.

Minimum and maximum widths. Farmers' opinions as to the minimum and maximum widths permissible without reducing the effectiveness of the self-feeding program were as follows:

One-half believed that the feeding space could be reduced to less than 3 inches per head, and one-third placed the minimum space at 3 to 5 inches per head (Table 9). Only three operators considered less than 2 inches an adequate minimum.

Opinions as to the maximum allowable space varied considerably. More than half felt that 3 to 7 inches per head was a suitable maximum, while about one-third considered 9 or more inches permissible.

Minimum and maximum number of cattle. Most farmers believed that there was considerable flexibility in the size of drove that could

Table 9. — Actual and Suggested Silo Width Allowances per Head for Cattle Self-Fed From Horizontal Silos, 45 Illinois Farms, 1957

Horizontal space per animal[a]	Actual						Suggested[d]			
	For feeding period of 1956-57		For warm-weather operations[b]		For largest number ever self-fed[c]		Minimum space		Maximum space	
inches	*no.*	*perct.*	*no.*	*perct.*	*no.*	*perct.*	*no.*	*perct.*	*no.*	*perct.*
1.0–2.9	10	23	3	13	12	27	22	51	1	2
3.0–4.9	19	44	13	54	21	47	15	35	11	25
5.0–6.9	9	21	1	4	9	20	6	14	12	27
7.0–8.9	3	7	6	25	2	4	0	0	5	12
9.0 and above	2	5	1	4	1	2	0	0	15	34
All widths	43	100	24	100	45	100	43	100	44	100
	inches		*inches*		*inches*		*inches*		*inches*	
Average	4.1		4.9		3.7		3.4		7.9	
Median	4.0		3.6		3.0		2.9		6.3	

[a] Bottom width of the silo used for self-feeding.

[b] Data were obtained only from farmers having experience with self-feeding of silage beyond May 15. Silos were seldom open later than June 15.

[c] These data reflect the largest number of cattle self-fed at any one time on each farm regardless of season of the year or length of experience. Most of the low stocking rates were found on farms whose operators had used self-feeding for only one year.

[d] Derived from farmers' opinions as to the smallest and largest droves that could be successfully self-fed at one time from their silos during a regular feeding period. Part of the difference in opinion among farmers results from differences in size of cattle considered, pecularities of individual silos, and differences in experience with various stocking rates.

be handled successfully with a given silo. The largest drove that could be self-fed without crowding was commonly set at two to three times the smallest drove capable of keeping the silage fresh during self-feeding.

Feeding gates

Three types of feeding gates were in use on the study farms: electric wires, manger-type gates suspended by a pole resting on the side walls of the silo, and self-supported gates resting on the floor of the silo. Twenty farmers used suspended gates, 18 used electric wires, and 8 used self-supported gates.

Feeding gates on the farms were seldom constructed according to a standard plan.[1] Half the farmers formulated their own plans with ideas from a variety of sources. One-fourth copied the system used on neighboring farms. The rest obtained plans from public agencies, farm magazines, or professional farm managers.

Electric-wire gates consisted of a fence charger, an insulated wire to and along one side of the silo, insulators, a bare cross wire, and fasteners for the cross wire. Two-strand barbed wire, or the equivalent of No. 10 or larger plain wire, was commonly used as a cross wire. The cross wire was fastened across the silo by staples driven into the walls or by hooks attached to inverted U-hangers on the side walls of the silo. A single wire located so that the cattle fed below it at all times was used on all except one of the farms; one farmer used two wires.

When used at a fixed height, as was the case on about half of the farms, the cross wire was kept about 36 inches above the floor and at least 12 inches from the silage. Many feeders fixed the height of the stationary wire so that it touched the cattle on the top of the shoulders if they tried to walk under it.

Varying the height of the cross wire was more effective than keeping it at a stationary level. This was done by driving staples in the side at the desired heights or having several hooks on the side hangers. With such an arrangement, an experienced operator could guide the feeding over a greater part of the face of the silo than with a stationary wire. Silage remained fresher and less hand labor was necessary than when the cattle were allowed to feed in one place.

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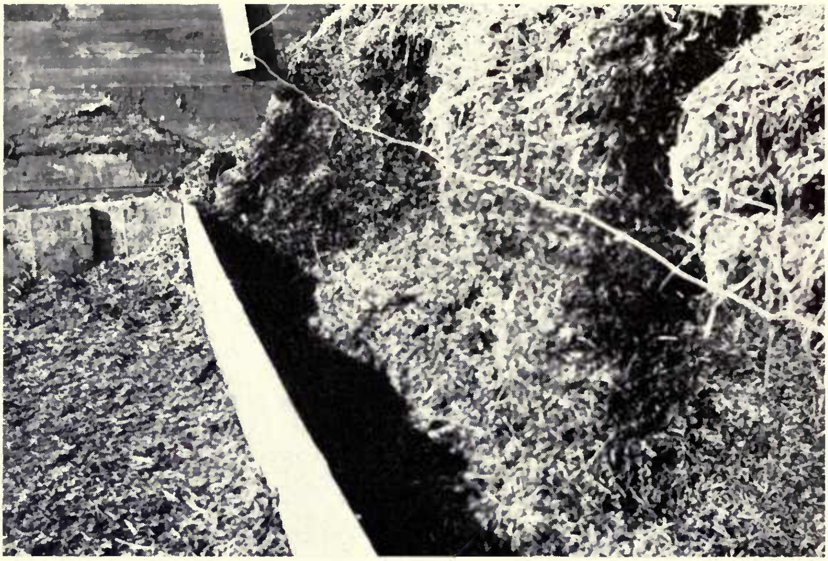
[1] For details of constructing a suspended or self-supported feeding gate, see Plan 518, Department of Agricultural Engineering, College of Agriculture, University of Illinois, Urbana, Illinois.



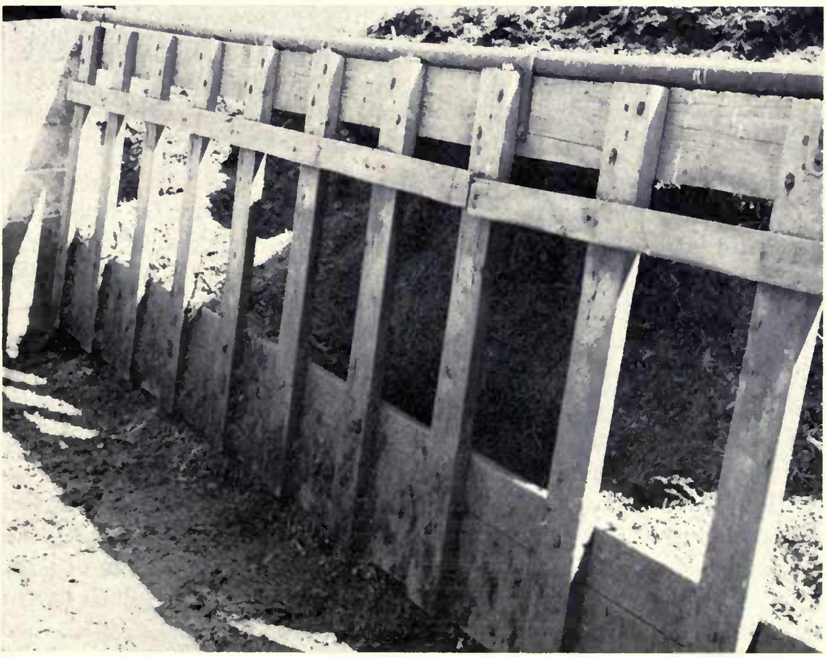
A footboard used with an electric-wire gate protects the silage at floor level, keeping it palatable and facilitating cleaning of the silo floor. (Fig. 4)

There were no fixed rules for the heights of the wire or the frequency of adjustment. The most successful operators closely observed the cattle and their feeding habits during the early stage of the feeding period to determine the necessary management of the cross wire. A common method was to start the wire about 4 feet high and move it down to about 2.5 feet over a period of three or four days. Any silage overhang that developed was broken down to floor level about one day before moving the wire forward.

The experiences of the farmers indicated that cattle usually fed about 3 feet above the floor and had to be forced to consume silage at floor level. However, unless a footboard (a 2- x 12-inch board on edge with braces at each end) was placed across the silo directly below the cross wire, thus protecting the silage from drainage, it was usually impracticable to force the cattle to use all the silage at floor level. Unprotected silage was frequently unpalatable and often resulted in greatly reduced consumption.

Suspended gates were used in silos up to 30 feet in width. Two-inch lumber was commonly used for their construction. The gate frame was usually made of 2- x 6-inch material. Larger sizes were avoided chiefly because of weight. Nails were used for some gates, but bolts appeared to be advisable. Cross poles of different sizes were used, but poles or iron pipe with the equivalent strength of a 6-inch wooden pole were found to be sufficient for suspending the gates from the side walls of silos up to 30 feet wide. Chains, steel cables, or tripled strands of No. 9 wire attached the gate to the support pole. Most of the gates were 5 to 6 feet in height, and were hung so that the bottom just cleared the silo floor. Maximum height above the floor was 6 inches, but the average clearance was only 1.5 inches. Close fits at the base of the gate increased protection against drainage.

Major differences of construction were in the placement and spacing of the vertical partition members. A simple and inexpensive gate consisted of only enough vertical members to support the gate panel. Horizontal space between members ranged from 6 to 18 feet and averaged 9 feet. The vertical space through which the animals fed



The most satisfactory type of gate with respect to control of cattle, waste of silage, and labor inputs was the suspended gate with individual feeding partitions and a solid-panel base. (Fig. 5)

ranged from 12 to 40 inches and averaged 20 inches. Another type of gate, preferred by most farmers, consisted of individual feeding stalls formed with vertical 2- x 6-inch members. Openings between the vertical partitions ranged from 11 to 15 inches and averaged 14 inches. Vertical space ranged from 20 to 46 inches, averaging 30 inches.

The base of most suspended gates was constructed as a solid panel for protection against drainage and hogs. This panel ranged up to 26 inches in height, averaging 15 inches.

The support pole was usually anchored at the side walls to keep the cattle from pushing the gate forward too rapidly. Gates were secured at least 12 inches from the face of the silo and kept there until the cattle had cleaned up what they could reach — usually 2.5 to 3.0 feet from the front of the gate. Overhangs were broken down by hand into the reach of the cattle.

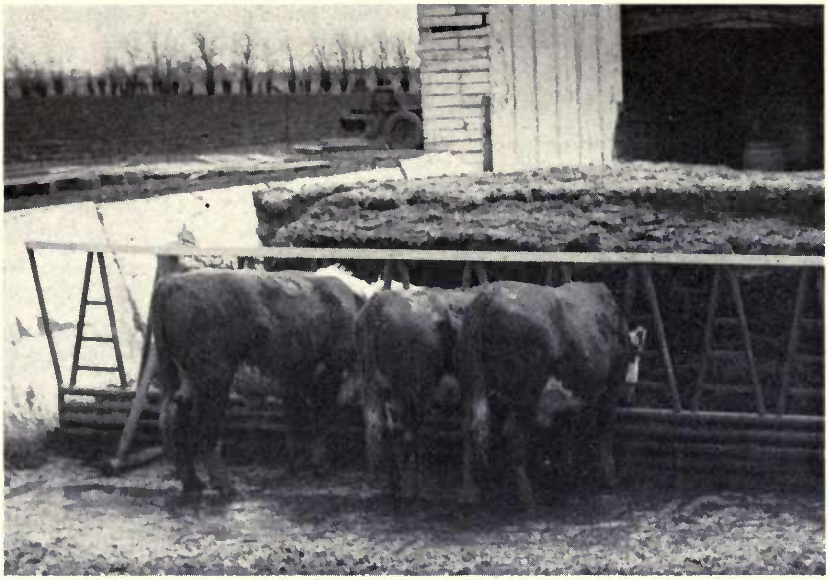
Waste silage in front of the gate and any spoilage along the side walls were removed before the gate was moved forward. Pressure from cattle reaching for fresh silage was often enough to move the gate forward when it was released. If the pole did not slide or roll freely from the pressure of the cattle, a pinch bar or fence stretcher was used to move it. A tractor and power scoop were used to lift the support pole over posts that extended above the side walls.

Self-supported gates were used on eight farms. Those made of wood were similar to suspended gates except for a floor-level platform extending about 3 feet toward the cattle. The weight of the animals standing on this platform kept the gate from tipping toward the silage. A brace between the gate and the face of the silo was sometimes used for added stability.

Some gates were made of welded 2-inch iron pipe or angle iron. Triangular braces or runners extended about 2 feet from the base of the gate on the open side and 1 foot on the side next to the silage. Partition bars were commonly V-shaped rather than vertical.

Sectional self-supported gates effectively replaced suspended gates in some silos 30 feet or more in width. The difficulty of moving self-supported gates reduced their popularity. To move this type of gate, first all residue was removed from in front of it; then a pinch bar or tractor was used to shove the gate forward.

Relative merits of the three types of gates. Comparisons of the three types of feeding gates were made with respect to the following: initial and annual costs, control of cattle, exclusion of hogs, waste of silage, and labor requirements.



Self-supported gates were used on only eight farms. This one is made of iron pipe, with V-shaped partitions. Triangular braces support the gate. (Fig. 6)

Initial and annual costs are affected by the type of gate, materials used, and labor. If all materials were bought at retail value, the electric wire would be the least expensive system and the suspended gate the most expensive (Table 10). But annual costs showed an advantage of only $10 for an electric-wire gate in a system designed for approximately 100 cattle. Other differences among the types of gates, listed below, were of such magnitude as practically to eliminate both initial and annual costs from consideration.

Control of cattle. Suspended and self-supported gates gave more certain control of cattle than did electric-wire systems. Some animals were fearful of receiving an electric shock and refused to use the silo except when driven by hunger. There was also the possibility of a power failure or a broken cross wire permitting the cattle to get onto the silage or even to escape from the feedlot. Electric-wire and open-panel suspended and self-supported gates permitted animals to turn their heads over the open floor, thus increasing losses of silage from cattle dropping mouthfuls of silage on the floor.

Table 10. — Approximate Cost of Materials and Labor for Constructing Selected Types of Feeding Gates for a Horizontal Silo 25 Feet Wide, Illinois, 1957

Type of gate	Initial cost			Annual cost[c]
	Materials[a]	Labor[b]	Total	
Electric wire	$32	$16	$ 48	$ 9.44
Suspended	85	42	127	19.68
Self-supported	72	36	108	16.74

[a] Two-inch lumber and bolt construction were assumed for suspended and self-supported gates.
[b] Labor cost was arbitrarily set at half the value of materials.
[c] Annual costs include depreciation at 10 percent of initial cost, interest at 5 percent of average depreciated value, and all other costs at a total of 3 percent of initial cost. Electricity is a separate charge, but it amounts to only about $2 for a 3½-month feeding period.

On suspended and self-supported gates, a large vertical space coupled with a long horizontal opening sometimes permitted the cattle to get through the gate onto the silage. It also gave "boss" animals more control of the silo and, when cattle of different sizes were kept in the same lot, the smaller and more timid animals were often kept from getting enough silage. When individual feeding stalls were used, the cattle seldom managed to get through the gate onto the silage.

Exclusion of hogs. On 35 of the 49 farms, hogs had access to the silo. Nine operators could not keep them from getting into the silage. Most of the difficulty occurred on farms using electric wires, especially when the wire remained at a stationary height well above the hogs. The problem was usually more serious with corn than with grass silage.

Varying the height of an electric wire so that it would touch the hogs part of the time was usually effective in keeping them away from the silage all of the time. A 12- to 15-inch footboard made it more difficult for hogs to get to the silage without touching the wire.

Suspended and self-supported gates with solid panels at the bottom were the best barriers against hogs. V-shaped partitions increased the effectiveness of these gates. If hogs nevertheless got through the feeding spaces onto the silage, the only practical solution was to remove them from the feedlot.

Waste of silage. Waste of silage other than spoilage could not be measured, but 12 of 46 farmers found it large enough to be disturbing. Most of the loss occurred at floor level where drainage, manure, trampling, spoiled materials from the top of the silo, seepage from high-moisture silage, and hogs had made the silage unpalatable. Such losses were reported by eight of the 18 operators who used electric wires. Only two farmers who used suspended gates reported significant losses.

Other losses occurred because the cattle dropped silage that they had pulled from the silo. Some farmers who used suspended gates found that partition members installed at an angle forced the cattle to turn their heads slightly to the side to get them through the opening, thus reducing losses from dropped silage. Some of the dropped silage fell at the base of the feeding gate and dried out or became unpalatable for other reasons. Some fell on the feeding floor and was immediately lost. Losses from dropped silage were highest with grass and small grain silage. Only two farmers who fed corn silage reported such losses, and these resulted largely from using an electric wire with no protection at floor level.

Labor requirements of the three types of gates are discussed on page 34.

General performance. The general performance of feeding gates was reported unsatisfactory on a third of the farms. Electric wires accounted for half of the unsatisfactory systems. Users of these electric wires either planned to change to another type of feeding gate or were undecided as to what to do. The difficulty of handling a self-supported gate caused a shift away from self-feeding on at least one farm. On other farms, changes to be made in suspended and self-

An open-panel gate made with only enough vertical members to support the gate panel is simple and inexpensive to build. However, if the vertical space is too large, cattle may be able to climb through the gate onto the silage. (Fig. 7)

supported gates were minor; they involved such matters as adjusting the spacing of vertical members or increasing the height of the bottom panel. None of the users of these two types of gates contemplated a change to an electric wire.

Labor

Jobs and frequency of performance. The self-feeding of silage includes five jobs: moving or adjusting the feeding gate; loosening silage; removing spoilage; cleaning the silo floor; and supervising the operation. Records of the jobs done and the frequency of each were obtained from 49 farmers. Total labor inputs were available from 44 of the records, and most of them included data for the individual jobs. Jobs were sometimes combined in such a way that farmers could not make accurate divisions of labor inputs.

The frequency of performance of the five jobs varied considerably among farms (Table 11). Unlike the distribution of feed by hand or with mechanical equipment, the jobs were performed irregularly rather than as an everyday routine.

Adjusting the feeding gate. Periodic adjustment of the feeding gate was necessary on all farms. The frequency of this job varied through the seasons with changes in the rate at which silage was consumed. On the average, one-fifth of the farmers adjusted the gate daily, about half moved it every other day, and, on the rest of the farms, the average frequency of this job varied from twice a week to once in two weeks.

Loosening silage. More than half of the farmers believed that loosening of silage was necessary for adequate feed consumption. Of these, two-thirds loosened the silage by hand once or twice a day and the rest loosened it every other day or less frequently. On two-fifths of the farms, no help was given the cattle in getting the silage.

Removing spoilage. Surface and side spoilage were removed as feeding progressed on all except one farm. This job varied from twice daily to once in three weeks, depending upon the general chore routine and the amount of spoilage. Nearly three-fifths of the farmers removed surface spoilage more than once a week; about a third did the job weekly; and the rest postponed the removal of surface spoilage to convenient periods to help smooth the over-all labor demands.

Except in very cold weather, removing spoilage and thus exposing good silage caused no difficulty in the winter, even if the good silage were exposed as long as three weeks. In very cold weather, some of the

Table 11. — Frequency of Jobs in Self-Feeding Silage to Beef Cattle From Horizontal Silos, 44 Illinois Farms, 1956-57[a]

Frequency	Adjust gate		Loosen silage		Remove spoilage		Clean floor		Check operation	
	no.	*perct.*	*no.*	*perct.*	*no.*	*perct.*	*no.*	*perct.*	*no.*	*perct.*
2 per day	1	2	4	9	1	2	0	0	6	13
1 per day	9	20	12	27	4	9	0	0	15	34
1 per 2 days	20	46	5	12	8	18	0	0	2	5
1 per 3 days	7	16	1	2	4	9	0	0	0	0
2 per week	2	5	0	0	3	7	3	7	0	0
1 per 4 days	0	0	1	2	2	5	0	0	0	0
1 per 5 days	1	2	0	0	3	7	0	0	0	0
1 per week	3	7	1	2	14	32	7	16	0	0
1 per 10 days	0	0	0	0	2	5	3	7	0	0
1 per 2 weeks	1	2	0	0	1	2	12	27	0	0
1 per 3 weeks	0	0	0	0	1	2	3	7	0	0
1 per month	0	0	0	0	0	0	8	18	0	0
1 per 2 months	0	0	0	0	0	0	4	9	0	0
1 per 3 months	0	0	0	0	0	0	1	2	0	0
1 per year	0	0	1	2	0	0	3	7	0	0
Not done	0	0	19	44	1	2	0	0	21	48[b]
Total	44	100	44	100	44	100	44	100	44	100

[a] Based on the average for the complete period of self-feeding of silage.
[b] This job was not done as a separate activity on these farms; rather it was combined with other jobs.

good silage that would have been protected by the spoiled material froze. Spoilage along the side walls was removed each time the feeding gate was moved forward. On all farms, spoilage was removed by hand forks. The waste was pitched onto the silo floor or directly into a spreader.

Cleaning the silo floor. On all farms, tractor-mounted manure scoops or scrapers were used to clean the floor of the silo. This job usually coincided with cleaning of the feedlot, which was done two or three times a month on most farms. Spoiled silage that had been pitched on the silo floor was removed when the floor was cleaned. All waste was hauled directly to the fields and spread when the ground was suitable for travel.

Supervising the operation. About half of the farmers made a special trip to the silo once or twice a day to check the self-feeding operation. The rest combined supervision with one or more of the regular jobs.

Relationship to size of drove. Many of the farmers fed more than one lot of cattle during the year. On some farms, lots overlapped. On others, they were fed in consecutive periods. The number of head

Table 12. — Relationship Between Size of Drove and Labor Inputs per 100 Head for Specified Jobs in Self-Feeding Silage to Beef Cattle From Horizontal Silos, 44 Illinois Farms, 1956-57

Size of drove	Farms[b]	Average size of drove	Average daily labor input per 100 head[a]				
			Adjust gate and loosen silage[c]	Remove spoilage	Clean floor	Check operation	Total[d]
					hours		
29– 50...........	9	43	.23	.24	.24	.16	.90
51– 75...........	12	63	.33	.18	.25	.11	.86
76–100...........	10	89	.24	.17	.15	.08	.63
101–150...........	8	118	.28	.12	.14	.03	.52
151–230...........	5	202	.10	.06	.05	.04	.23
All farms........	44	90	.25	.17	.18	.09	.68

[a] Farms on which a job was not done were included in the computation of averages using zero for the labor input.
[b] These are the numbers of farms for which records of total labor inputs were available. Records of labor for individual jobs range from 38 to 44.
[c] Labor inputs for adjusting the feeding gate and loosening the silage were combined because they were often done at the same time.
[d] The sum of the average labor inputs for individual jobs does not necessarily equal the average total labor input. A few labor records were indivisible by jobs and were omitted from the job analysis but retained in the totals.

days on silage was calculated to get a measure of the size of drove that would permit farms to be compared on an equivalent basis.

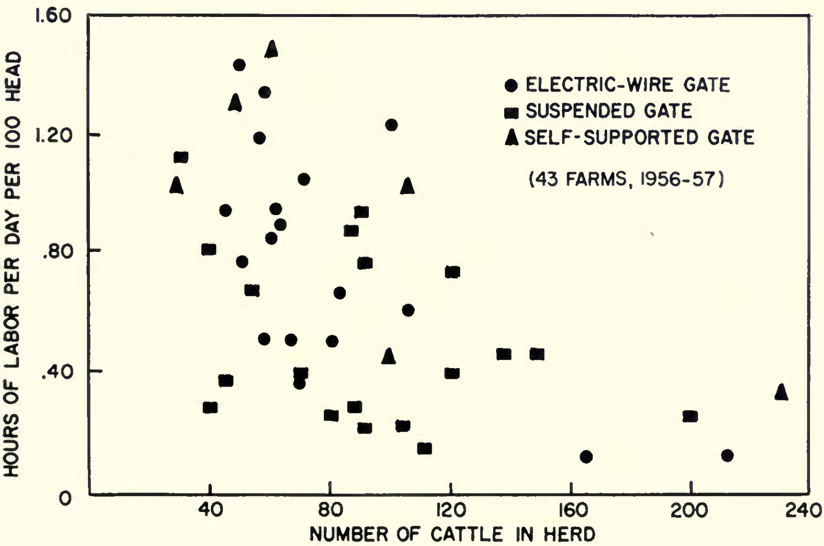
Droves averaged 90 head for all farms on the basis of head days on silage, with a range of 29 to 230 head on individual farms.

The average labor inputs for each of the jobs performed in self-feeding decreased as the size of drove increased (Table 12 and Fig. 8). This was usually because part of the time for performing each job was fixed regardless of the size of drove. The effects of a larger drove were least apparent in the data on adjusting the feeding gate and loosening silage, largely because of the influence of the type of gate on labor requirements. For all silage chores the average daily labor inputs were nearly an hour per 100 head with the smallest droves, decreasing to less than one-fourth of an hour with the largest droves.

Labor inputs for each of the jobs and for the complete operation of self-feeding of silage were standardized, by fitting a line to the individual observations for all farms, in order to eliminate the irregularities among the different groups. The standardized average labor inputs (Table 13) differ only slightly from the actual inputs shown in Table 12.

Standardized total labor inputs per drove increased with size of drove to about 100 cattle (Table 13). With 100 to 160 head, total labor inputs were relatively constant. With droves of larger size, total labor inputs decreased. The labor economies that appeared as droves increased to medium size were primarily results of reductions in average fixed time. The subsequent drop in total labor per drove with the largest operations was apparently related to more effective methods of operation and better management. It was not due to increased mechanization, since the level of mechanization was about the same on all farms. In order to compare management practices among the 49 farms and relate them to size of drove, it would have been necessary to accurately time each of the operations performed in self-feeding silage. This was not done because of the irregular occurrence of jobs.

All labor data are expressed in terms of daily inputs. The data can be converted to seasonal estimates by using the appropriate self-feeding period, usually four to five months. It should be recognized, however, that self-feeding programs do not exert an equal daily demand for labor, as might be surmised from Tables 12 and 13. The average frequency of jobs on most of the farms (Table 11) varied from once a day for checking the operation to once or twice a month



Farms with a larger drove had lower daily labor inputs per 100 head than farms with fewer cattle. This chart also reveals the influence of type of gate on labor inputs: on farms with approximately the same number of cattle, those using suspended gates more frequently had lower labor inputs than those using electric-wire and self-supported gates. (Fig. 8)

Table 13. — Standardized Daily Labor Inputs for Specified Jobs and for the Complete Chore of Self-Feeding Silage to Beef Cattle From Horizontal Silos, by Size of Drove

Size of drove	Daily labor inputs per 100 head					Total labor for drove
	Adjust gate and loosen silage	Remove spoilage	Clean floor	Check operation	All silage chores	
			hours			
20	.32	.28	.33	.14	1.07	.21
40	.30	.23	.27	.12	.92	.37
80	.25	.17	.18	.10	.70	.56
120	.20	.11	.12	.09	.51	.61
160	.14	.08	.08	.06	.36	.58
200	.10	.06	.05	.03	.24	.48
240	.06	.05	.04	.02	.17	.41

for cleaning the silo. As most jobs are flexible, a self-feeding operation could be budgeted into a farming program as long as at least half of the average labor requirements could be fulfilled within any given week. All labor needs would have to be met within a month.

Relationship to feeding gate. Labor inputs for self-feeding silage to beef cattle differed significantly among farms with the three types of feeding gates. Systems in which suspended gates were used were the most effective; they required only 0.41 hour per 100 head per day for all silage chores (Table 14). Daily labor inputs were 0.82 hour per 100 head on farms with electric wire and 1.03 hours on farms with self-supported gates.[1] The number of systems with self-supported gates was low, but their labor inputs were consistently high.

Farms grouped according to type of feeding gate differed as to size of drove. Those with suspended gates averaged 97 head of cattle; those with electric wires averaged 81; and those with self-supported gates averaged 65 head. Since average total labor inputs decreased as size of drove increased, small droves were partly responsible for the higher labor inputs on farms with self-supported gates. Conversely, a part of the reduction in labor inputs on farms with suspended gates resulted from economies related to scale.

Labor inputs decreased about 0.02 hour for each five additional head of cattle. If the labor inputs for each of the three groups of farms as classified by type of gate are adjusted to the over-all drove average of 90 head, the daily labor inputs per 100 head become 0.44

[1] Median figures were used for most comparisons because of the distortion of averages by extremes.

Table 14. — Relationship Between Type of Feeding Gate and Labor Inputs for the Complete Chore of Self-Feeding Silage to Beef Cattle From Horizontal Silos, 43 Illinois Farms, 1956-57

	Electric-wire gate	Suspended gate	Self-supported gate
Number of farms[a]	18	19	6
Average number of head	81	97	65
Daily labor inputs per 100 head, hours			
Average	.79	.53	.92
Median	.82	.41	1.03
Median adjusted to drove average of 90 head	.78	.44	.93

[a] Time data for six farms were not usable.

hour for systems with suspended gates, 0.78 hour for those with electric wires, and 0.93 hour for those with self-supported gates.

Adjusting gate and loosening silage. Each move of a self-supported gate required considerably more time than was needed to handle other types of gates, but self-supported gates were moved only once in 4 days, while the other gates were moved at least every other day. Thus average labor inputs for moving the gates did not differ among the three types. The infrequency with which self-supported gates were moved reflects the difficulty of the job rather than an advantage of the gate.

Evidence indicates that cattle were able to feed through suspended gates with less assistance than through gates of other types. Only one-third of the farmers with suspended gates loosened silage as a part of their regular chore routine (Table 15). This job was done by three-fourths or more of the farmers who used other kinds of gates.

The influence of type of gate is revealed in the combined labor inputs for loosening silage and moving the gate (Table 15). These two jobs took more than three times as much labor on farms with self-supported gates as on those with suspended gates. Labor for these jobs on farms using electric wire was at an intermediate level. The higher labor inputs for electric wires and self-supported gates were largely due to the farmers' resorting to some degree of hand-feeding to compensate for the inadequacies of the gates.

Removing spoilage required the smallest amount of labor on farms using suspended feeding gates (Table 15). On these farms, surface spoilage was removed once in 5 days. This job was done once in 4 days on farms where electric wire was used and once in 3 days on

Table 15. — Relationship Between Type of Feeding Gate and Labor Inputs for Specified Jobs in Self-Feeding Silage to Beef Cattle From Horizontal Silos, 43 Illinois Farms, 1956-57

	Electric-wire gate					Suspended gate					Self-supported gate				
	Adjust gate, loosen silage	Loosen silage[a]	Remove surface spoilage	Clean silo floor	Supervise operation	Adjust gate, loosen silage	Loosen silage[a]	Remove surface spoilage	Clean silo floor	Supervise operation	Adjust gate, loosen silage	Loosen silage[a]	Remove surface spoilage	Clean silo floor	Supervise operation
Number of farms	18	18	18	18	18	19	19	19	19	19	6	6	6	6	6
Farmers doing job															
Number	18	13	17	18	9	19	6	19	19	11	6	5	6	6	3
Percent	100	72	94	100	50	100	32	100	100	58	100	83	100	100	50
Daily labor inputs per 100 head, hours															
Average	.26	...	.19	.25	.10	.20	...	.13	.11	.09	.45	...	.25	.22	.07
Median	.19	...	.15	.23	.06	.12	...	.10	.08	.05	.38	...	.27	.18	.04

[a] The jobs of adjusting the feeding gate and loosening silage were combined on most farms; therefore labor inputs for the two jobs could not be separated.

farms with self-supported gates. Apparently, farmers tried to alleviate some of the shortcomings of electric-wire and self-supported gates by keeping the silage as palatable as possible.

Cleaning the silo floor took the smallest amount of time in systems using suspended gates and the greatest amount on farms with electric wires (Table 15). The higher labor inputs on farms with electric wires were largely due to more frequent cleaning. Frequent cleaning was necessary with electric-wire systems because, with one exception, farmers using electric wires did not use footboards. This meant that, to keep the silage usable at floor level, the floor had to be cleaned more often than when drainage was blocked by a footboard or the base of a suspended gate. A footboard or gate with a solid base also facilitated cleaning, as less care was needed to keep from shoving manure and water into the silage. Another reason for the high labor inputs on farms using electric wires was that waste of silage was greater with these types of gates, and the increased quantity of waste material close to the feeding gate created a more frequently recurring drainage problem.

Supervising the operation as a separate activity from other jobs did not differ among systems with the three types of gates (Table 15). The job was done on about half of the farms with each type of gate.

Relationship to kind of silage. There was no significant relationship between kind of silage and labor inputs, except perhaps for oat silage. Labor inputs were lower for oat silage but the small number of records for this type of silage prevents a definite conclusion.

Although labor inputs did not differ between farms with grass and those with corn silage, relatively more farmers reported loosening of grass silage as a regular chore than did feeders of corn silage. Also, field observations indicated that handling grass silage was more difficult than handling corn silage, particularly when the silage was frozen.

Farmers' opinions

Only two farmers were thinking of changing from self-feeding to some other method of handling silage. The majority expressed satisfaction with the systems in use during the 1956-57 feeding period. Some of them had made changes in the system earlier. Five farmers had changed from calves to yearlings because they believed that the smaller cattle could not get enough to eat through self-feeding. Two operators had shifted from grass to corn silage.

PROBLEMS IN SELF-FEEDING

Frozen silage

Silage has been successfully self-fed from horizontal silos as far north as Canada, but freezing sometimes causes difficulty even in central Illinois. Frozen silage usually causes extra work and loss of silage; in very cold weather it may even prevent self-feeding.

Some difficulty with frozen silage during 1956-57 was reported by 32 of the 49 cattle feeders included in the study. Extra labor was needed on 22 farms. A few farmers had difficulty for more than a month, but the average period of extra work was 12 days for the season. Extensive freezing curtailed or stopped self-feeding for short periods on eight farms during 1956-57, and one operator discontinued self-feeding for the rest of the year because of frozen silage. February, 1958, was colder than normal, with minimum temperatures in the northern half of Illinois falling to 0° F. or below during most of the month. Half of 38 farmers who answered inquiries reported that freezing stopped self-feeding for periods ranging up to a month. The period off self-feeding averaged 11 days for farmers who reported difficulties.

Freezing on top of the silo seldom exceeded the depth of the surface spoilage. The maximum depth of freezing ranged from 1 to 15 inches, with an average of 5 inches. Removal of this frozen material required some extra labor, but little or no good silage was lost. Freezing along the side walls required extra work, usually daily, and, as the frozen chunks were usually thrown out of the silo, silage was wasted. Freezing along the face of the silo had the most serious consequences: it either reduced or stopped self-feeding entirely.

Frozen silage was usually loosened manually with a fork, pick, or saw, then thrown out of the silo or on the floor behind the cattle. With an electric-wire feeding gate, a tractor loader could be used to loosen frozen silage during the coldest periods. Some operators let the cattle fend for themselves when silage was frozen, but this was unsatisfactory. Cattle ate holes into parts of the silo while other areas became dried and frozen. The effective feeding space was thus reduced and the resulting irregularity of the face of the silo caused waste of silage, especially when the temperature moderated.

Temperature. The experiences of the farmers indicated that minor problems at least could be expected from freezing when minimum daily temperatures were 10° F. or below for several consecutive days. Maximum daily temperatures during such periods were usually high enough to prevent severe freezing. Extensive freezing could be expected when the minimum daily temperature was 0° F. or below for extended periods.

In the light of these two criteria — several consecutive cold days (an average of three) and temperatures of 0° F. or below — the winter temperature records of various weather stations in Illinois from December, 1930, to February, 1957, were examined to determine the probability of freezing of silage in various parts of the state.

According to the data,[1] the southern half of Illinois is relatively free from severe freezing of silage. From 1930 to 1957 none of the weather stations south of the Bloomington area[2] recorded more than 1 year in 10 with temperatures low enough for severe freezing of silage for more than 3 days of any month from December through February. The Galva, Ottawa, and Joliet areas, north of Bloomington, are free from the possibility of severe freezing in 7 to 8 years out of 10. In the Rockford area, in northern Illinois, temperatures can be expected to be low enough to cause extensive freezing of silage for 3 days to a week during each of the three winter months in about 1 year in 3.

Although temperature was the main determinant of freezing problems, there were other influences on the severity of freezing. Among them were the orientation of the silo, kind of side wall, kind of silage, and temperature of the silage.

Orientation of the silo. Correct orientation of the silo helped to minimize freezing. The relationship between freezing and orientation of the silos on the 49 farms was as follows:

	Direction which feeding end faced			
	North	*South*	*East*	*West*
Trouble from freezing, number	9	13	3	7
No trouble from freezing, number	1	11	3	2

Almost half the farmers using a north-south orientation with feeding from the south end reported no trouble. This orientation provides for maximum exposure to the sun and protection from prevailing winter winds. Half the farmers using an east-west orientation with feeding from the east reported no trouble; the main difficulty with this type of exposure is that the north wall is always shaded. Ninety percent of the farmers with silos facing north reported difficulty from freezing, and 78 percent with silos facing west had trouble. Some of the most severe freezing occurred in silos that faced west.

[1] U. S. Department of Agriculture, Weather Bureau, *Climatological Data, Illinois Section,* Volumes 35 to 45, and U. S. Department of Commerce, Weather Bureau, *Climatological Data, Illinois Section,* Volumes 45 to 62.

[2] Bloomington is located in central Illinois.

Kind of side wall. The earth keeps the silage from freezing along the walls of trench silos. Only one conventional trench silo was included in the study, but one-fourth of the farmers had built a bank of earth behind their wood or concrete walls. The chief purpose of this bank was to provide support for the side walls, but it also eliminated freezing.

Freezing of silage along north walls or walls shaded by a building from direct sunlight reached depths of 18 to 24 inches during the coldest periods of 1956-57. The average was about 9 inches. Periodic thawing prevented serious difficulties except during such protracted cold periods as that of February, 1958. The depth of freezing was about 15 percent greater in silos with unprotected concrete walls than in wooden structures. Two-inch wooden walls provide more insulation than 6- to 8-inch poured concrete or concrete block walls.[1]

Kind of silage. Corn, grass-legume mixtures, and small-grain silages were all subject to freezing in the self-feeding program. Grass silage in any condition was more difficult to handle than other kinds of silage and was especially troublesome when frozen. In six of the eight systems in which freezing had stopped self-feeding in 1956-57, farmers were using grass silage. Nearly three-fourths of the 19 farmers who were forced to temporarily stop self-feeding the following winter were using grass silage.

Temperature of silage. Variations in surface freezing were due partly to the temperature of the mass of silage. Forages that contain the proper amount of moisture generate heat during the process of fermentation. This heat dissipates slowly and helps to retard freezing. Forages that contain too much moisture do not ensile properly. Their use may result in a "cold" silo that will be particularly vulnerable to low temperatures.[2]

Appraisal of the freezing problem. Some farmers have difficulty with frozen silage, but no part of Illinois is cold enough during a normal winter to prevent self-feeding from a horizontal silo for more than a few days if the silage program is properly managed. Harvesting forages at the correct stage of maturity and packing them properly into the silo, orienting the silo to obtain maximum benefit from the sun, keeping an adequate number of cattle feeding from the silo, managing the feeding gate to assure removal of silage from the entire

[1] *Heating, Ventilating and Air Conditioning Guide,* 35th edition, 1957, American Society of Heating, Ventilating and Air Conditioning Engineers, 62 Worth Street, New York 13, N. Y.

[2] Joint Committee on Grassland Farming, *New Grassland Livestock Handbook,* University of Oklahoma Press, Norman, Oklahoma, 1957, p. 31.

exposed area, and protecting above-ground walls with a bank of earth will assure relatively trouble-free operation of a self-feeding program anywhere in Illinois.

Drifting snow

Wind-blown snow sometimes drifts in the feeding area of a horizontal silo and must be removed if self-feeding is to continue. Troublesome drifts did not occur more often than once or twice a year and few farmers had made provision to check them. About half of the operators, however, considered that drifting snow caused enough difficulty to justify protective measures. Orientation of the silo to take advantage of prevailing winds helped, but most farmers believed that some type of windbreak would be more effective. When heavy drifts were encountered, the snow was removed from the silo with a tractor loader.

Drainage

Water and manure on the floor of the silo were controlled by sloping the floor properly and cleaning periodically with power equipment. Fewer than one-fourth of the farmers were seriously troubled by inadequate drainage during the 1956-57 feeding period. Manure hindered self-feeding on only five farms and made adjustment of the feeding gate difficult on only two farms.

Drainage problems were infrequent, but when they occurred the situation was usually serious. Spring was the critical period, especially with silos that did not have a paved approach. On farms with these silos, it was often impossible to get to the silo with tractor equipment for a month or more. Manure that had been frozen or remained firm during cold weather became semi-liquid after rains and flowed into the feeding area, spoiling large quantities of silage. Chore labor was difficult and disagreeable. Attempts to open drainage channels by hand were usually unsuccessful.

Problems brought on by inadequate drainage can be minimized by giving the floor plenty of slope. The approach to the silo should be paved or the silo should join a paved lot to permit year-round use of tractor equipment. Keeping the silo relatively clean is a preventive measure, although manure and waste silage can be allowed to accumulate during part of the year without causing a great deal of difficulty. Farmers who had no difficulty with drainage cleaned their silos slightly more often than three times a month.

Low consumption of silage

Relatively lower consumption of silage with self-feeding than with hand-feeding systems was reported by 9 of 49 farmers. This problem occurred most often with calves. Six of these nine farmers fed grass or oat silage; they stated that the cattle could not pull enough silage from the silo. Little difficulty was experienced with corn silage, regardless of the size of the cattle fed.

Apparently electric-wire feeding gates increased the problem of getting a full feed of silage into the cattle. Eight of the nine farmers who reported less than adequate consumption of silage used electric wires.

Mixed lots of cattle caused some difficulty, regardless of the type of feeding gate used or kind of silage fed. Larger animals sometimes became bossy and drove the smaller ones from the silo.

Farmers who were most successful fed corn silage or helped to loosen grass silage, kept cattle of uniform size, and used either a suspended or a self-supported feeding gate.

SUMMARY

Self-feeding of silage from horizontal silos is a relatively new practice in Illinois cattle-feeding operations. Many farmers are using the method successfully, but for some, inexperience and the apparent simplicity of self-feeding have caused difficulties with results ranging from the need to add labor to failure of the feeding program.

The systems on 49 Illinois farms were studied during 1957 and 1958 to provide information on operating self-feeding programs.

Silage was self-fed to an average of nearly 100 cattle per farm. Cattle were equally divided between calves and yearlings, and most graded good-to-choice or above. Purchases were usually made in the fall and the cattle were sold 9 to 12 months later at weights of 900 to 1,100 pounds. The usual program included a 4- to 6-month period of self-feeding silage beginning in December. About the same number of cattle were fed grass silage as were fed corn silage. Daily rates of gain averaged 1.7 pounds for the feeding period.

Horizontal silos and the self-feeding of silage resulted in more paved area than in the usual feedlot, but did not affect cattle buildings or feed-processing equipment. The need for mechanical distribution systems was reduced and, as a result, hand-feeding of concentrates to relatively large droves was common.

Farmers in the study had built horizontal rather than upright silos chiefly because of the lower initial cost and the reduction in labor achieved through self-feeding. Nearly all the silos were built in 1954 or later. Most had paved floors with walls of either concrete or treated wood. The capacities averaged 181 tons of silage. About three-fourths

of the silos were constructed by farm labor. Initial costs of 200-ton silos varied from $5 to $9 per ton of capacity. The farmers placed the useful life of horizontal silos at 15 to 30 years.

Making and keeping good silage was a problem on some farms. Packing along the side walls was frequently inadequate, resulting in spoilage of silage. Surface spoilage accounted for an average loss of 9 percent of the total weight of forages ensiled at an average volume of 232 tons; however, farmers with the most effective preservation measures kept spoilage losses below 5 percent. Spoilage decreased by one percentage point for each additional 50 tons of silage within the observed range of 60 to 500 tons. To minimize spoilage losses, the farmers recommended a silo with a width of at least 20 feet containing 5 to 7 feet of settled silage.

Few farmers used surface covers, but black polyethylene had aroused considerable interest. A major problem with synthetic covers was holding them in place and preventing mechanical damage. Low-value forages were effective as surface covers on some farms.

Silage conditioners were used in a few silos containing grass-legume forages. Farmers found it difficult to get an even distribution of the conditioning material and doubted its value.

Labor for harvesting and storing forages averaged 4.1 hours per acre for grass silage and 6.9 hours per acre for corn silage. The least productive farmers worked more than twice as long as the most productive in making a given quantity of silage. Size of crew, yields of forages, distances traveled, and length of the harvesting season affected labor inputs.

Usually the proper practices for making and keeping silage were known, but were not carried out satisfactorily. About two-thirds of the farmers were planning changes so as to do a better job.

Most farmers were experienced cattle feeders, but few had more than 2 or 3 years of experience with self-feeding of silage. Most expressed satisfaction with self-feeding, but some were having difficulty with parts of the operation.

Width of the silo affected the feeding as well as the storing of silage. Excessive width in relation to size of drove permitted freezing of silage in winter and loss of palatability in summer. Crowding of cattle reduced consumption of silage.

Horizontal feeding space averaged 4 inches per animal during the 1956-57 feeding period. Three inches per animal resulted in no ill effects, and 2 to 3 inches per animal were generally satisfactory, although crowding was apparent on a few farms. Most farmers believed that space allotments were flexible; the largest drove that could be self-fed without crowding was commonly set at two or three times the smallest drove capable of keeping the silage fresh.

The feeding gate was a major part of the self-feeding programs. Three types were in use: electric wires, suspended gates, and self-supported gates. Control of cattle, labor requirements, difficulty of work, waste of silage by the cattle, and access of hogs to the silage were all affected by the type of gate, to such an extent that differences among the gates in initial and annual costs were virtually eliminated from consideration of the relative merits of the three types.

Feeding gates performed satisfactorily on two-thirds of the farms. Electric wires accounted for half of the troublesome situations, mainly because they provided no protection against hogs and drainage, and because waste of silage was sometimes excessive. Self-supported gates were difficult to move. Suspended gates were the most effective in nearly all respects.

Five jobs were required in the self-feeding of silage: moving the feeding gate; loosening silage; removing spoilage; cleaning the silo floor; and supervising the operation. Some jobs were performed regularly while others were done on the basis of need. Frequency of jobs varied greatly among farms. Daily labor inputs per 100 head of cattle averaged 0.68 hour for the average drove of 90 head, but ranged from nearly an hour for small droves to less than one-fourth of an hour for droves of 200 or more. The type of feeding gate used was chiefly responsible for variations in labor inputs among farms with operations similar in size. Farms with suspended gates had the lowest labor inputs.

Freezing of silage often caused minor difficulties, but it seldom interrupted self-feeding except after extended periods of sub-zero weather. Maximum insurance against trouble from freezing was provided by a north-south orientation of the silo with feeding from the south end, protection of the sides by earth banks, use of corn or properly made grass silage, an adequate number of cattle feeding from the silo, and proper management of the feeding gate. Drifting snow caused little difficulty.

Drainage created a serious problem on less than one-fourth of the farms. Inadequate slope of the silo was the chief cause of drainage problems.

Low consumption of silage was reported by one-fifth of the farmers. This problem occurred most often with calves fed on grass silage. "Boss" animals in droves of mixed sizes aggravated the problem.

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