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Alternative Methods of Storing Silage and Their Costs

1955-56

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INTRODUCTION

Corn and grass silage are two of the most important crops harvested in the Northeast. An increasing proportion of the cropland on dairy and livestock farms is being used for these crops. One of the primary reasons for the continued growth in the importance of silage is a general recognition that in most cases more feed in the form of silage can be harvested from each crop acre than in any other way. The need for high production per cow and more efficient production methods to meet the cost-price squeeze has speeded the adoption of silage on many large commercial farms.

There are a relatively large number of different methods now being used to harvest and store silage. Numerous types and sizes of silos are available to farmers at a wide range in construction costs. Annual repairs and maintenance on these different silos and the amount of silage lost, because of spoilage while in storage, vary widely. Each type of silo and method of storage has its strong proponents.

Purpose

Because farmers are continuing to increase their acreage of silage crops and are building new silos and replacing old ones, this study was undertaken to provide a basis for comparing the cost of storing silage in different sizes and types of silos. To help farmers choose the best alternative for their particular situations, information on present construction costs for different types of silos of the same size is needed. The cost of repairs and maintenance, depreciation, and interest on investment for these silos must be determined. The amounts of silage which spoils in different kinds of silos needs to be determined as well. Finally with the above information and data on the amounts of labor required to fill different types and sizes of silos, unload them, and then feed the cows, a comparative analysis of the important methods of storing silage can be made.

Procedure

To make comparisons of the costs of storing and handling silage in different types and sizes of silo information was required from a variety of sources. Current construction costs at the farm for silos were obtained directly from manufacturers and dealers in New York and adjacent areas. Good estimates of rates of depreciation and experience on repair and maintenance expanse, and on losses of silage due to spoilage for different types of silos were not readily available. As a result a survey of farmers' experiences with the major types of silos was felt necessary.

To insure that a sufficient number of farmers be contacted, who had used trenches or poured concrete, concrete stave, wooden stave, or glass-lined steel towers, blocks of farmers in four different areas known to have sizeable numbers of one of these types of silos were chosen for study. All farmers who had silos within each of these blocks were interviewed. Detailed information on the type and size of each silo was obtained including estimates of its original cost, present value, and length of life. Costs of maintenance and major repairs were determined. Physical data on the amounts of spoiled silage at the top, sides, and bottom of the silo were obtained. Preservatives used, kinds of coverings placed over the silage and opinions about roofing silos were noted. Each farmer also indicated the amounts of labor used in filling silos, throwing down or unloading silage, and feeding it to the herd.

The four blocks chosen for study were parts of townships in Delaware, Jefferson, Livingston and Wyoming Counties. An additional group of farmers who were using trench or glass-lined steel silos were interviewed in these counties or wherever they could be found in Central and Western New York to provide a minimum of 20 experiences with the relatively new, glass-lined steel silos and 50 experiences with trenches.

Information was obtained from 158 farmers about the use of 245 different silos. This included data on 52 trenches and 193 tower silos of six different types. Wooden stave and concrete stave silos are most common in New York. Poured concrete silos have been used for a long period of time by some farmers in Lewis, Jefferson and St. Lawrence Counties and more recently have been built in other parts of the state. Glass-lined steel silos have been used by a relatively small group of farmers since 1950 and are actively being promoted in some areas. The number of tile and steel plate silos found on commercial dairy farms indicated them to be of minor importance at present. The number of records obtained for each of the types of silos is shown in table 1. The proportion of the total which each type makes up is not representative of the numbers of each type found in the state.

All of the 158 farmers who provided information about their silos were dairymen or at least sold fluid milk. There was considerable variation among farms within each of the four blocks studied as well as between areas. However, a large number of the farms could be characterized as two-man businesses with from 30 to 40 cows. As a group they were somewhat above average in size and efficiency but were not very different from those farms which have used silos for a number of years in New York.

TABLE 1. NUMBERS OF DIFFERENT TYPES OF SILOS STUDIED
(158 New York Dairy Farms, 1954-55)

Type of silo	Number
Towers:	
Wooden stave	61
Concrete stave	52
Poured concrete	35
Glass-lined steel	20
Steel plate	13
Tile	12
Trenches	52
Total	245

The actual cost of storing and handling silage was determined for each silo on all of the farms studied. Some general analysis of costs by types and sizes of silos was made. However, farmers had purchased these silos over a period of 50 years at a wide variety of prices. The wooden stave silos were generally smaller than the group of poured concrete silos. Because of such differences, direct comparisons by types of silos were not very meaningful.

TABLE 2. CHARACTERISTICS OF FARMS ON WHICH SILO RECORDS WERE OBTAINED BY AREAS, NEW YORK, 1954-55

Description	Averages for farms in: Jefferson County	Delaware County	Wyoming County	Livingston County
Number of farms	30	31	26	29
Size of Business				
Acres operated	180	206	204	290
Crop acres	100	62	120	175
Number of cows	35	35	31	35
Man equivalent	1.9	1.7	2.0	2.4
Productive man work units	600	500	590	760
Labor Efficiency				
Work units per man	325	315	311	320
Cows per man	20	21	16	15
Intensity				
Crop acres per cow	2.7	1.8	3.8	5.4
Percent of farm acreage in crops	55	30	59	60

To make the necessary comparisons a series of budgets were developed for each of four common sizes of silos among the five most important types. They were set up in the following manner. Current construction costs for the different sizes and types of silos delivered and set up for filling were obtained directly from manufacturers and dealers in the Northeast. Farmers' experiences were used to provide data on depreciation rates, repairs and maintenance, and amounts of spoilage. Time used in handling silage for the different types and sizes of silos also came from farmers' records. Operating costs for each size and type of silo were then computed using 1955 costs and prices.

THE COST OF STORING SILAGE

A farmer who wants to increase the amount of silage he has for feeding or to replace one or more of his silos can do one of a number of things. He can try to get along with temporary storage for a time. Snow-fence silos, heaps or piles of silage on the ground, and trenches have been used most commonly for this purpose. Permanent storage capacity can be obtained by erecting a number of different kinds and sizes of tower silos, constructing a permanent, but unlined trench, or most recently by building a bunker which usually has a concrete floor and two treated wooden sides. If he decides to obtain some kind of relatively permanent storage space he needs to know how much different kinds of silos will cost initially and how much his annual storage cost will be for each.

Initial Cost

Two items are primarily responsible for differences in the cost of new silos. One is the size of the silo. The second is the material from which it is constructed. There are four general types of tower silos which are currently being sold quite widely throughout the state:- wooden stave, concrete stave, poured concrete, and glass-lined steel. Estimates of the cost of the foundation, walls, chute, roof, and costs of erecting them at the farm in 1955-56 were obtained from New York dealers and manufacturers for four common sizes of each of these types of silos., The sizes chosen were 12 x 35, 14 x 40, 16 x 40, and 16 x 50 or the size sold which most closely approximated these four.

There are two classes of wooden stave silos. The most commonly used materials are white pine and spruce. The Oregon and western firs now on the market are denser woods which are expected to have a longer life than treated pine or spruce. Concrete stave silos are now available in two styles. The new plastic improved type provides a smoother inside wall than the regular concrete staves and are claimed to resist effectively deterioration caused by silage acids.

The average initial investment per ton of rated storage capacity at the farm in 1955-56 (table 3) decreases for each type of silo as size increases. Two 12 x 35 silos will cost from 35 to 50 percent more than one 16 x 40 silo made from the same material and will provide a little less storage capacity. For silos of all of the different types of material, this is true. Two small silos instead of one big one cannot be justified in economic terms.

Treated white pine or spruce, regular concrete stave, and poured concrete silos are quite competitively priced within each of the size groups. Wooden stave silos are usually not erected over 40 feet in height because of structural problems. Glass-lined steel silos are sold in three diameters:- 14, 17, and 20 feet. Most are constructed to be 40 feet in height. With these exceptions, direct comparisons of initial costs per ton of capacity can be made in table 3. Treated pine or spruce provides small capacity silos at the lowest initial cost per ton. Poured concrete silos clearly have the lowest initial cost per ton for the very large diameter silos of 50 or more feet in height. Otherwise, differences in initial cost for wooden stave (pine or spruce), regular concrete stave, and poured concrete silos in each of the size groups are not significant.

TABLE 3. INITIAL INVESTMENT PER TON OF RATED STORAGE CAPACITY FOR TOWER SILOS
(Average of New York Dealers' Estimates of Prices at the Farm, 1955-56)

Kind of material	Size of structure 12 x 35 (84 tons)	14 x 40 (138 tons)	16 x 40 (180 tons)	16 x 50 (248 tons)
	(initial investment per ton)			
Wooden stave:				
White pine or spruce	$15	$12	$11	$--
Oregon fir	20	16	14	--
Concrete stave:				
Regular	16	13	11	11
Plastic improved	22	18	16	14
Poured concrete	17	13	11	9
Glass-lined steel*	--	35	28**	25***

* Includes cost of bottom unloader as well
** Cost per ton for 17 x 40 silo
*** Cost per ton for 20 x 40 silo

The initial cost of an unlined trench silo is relatively small compared with any of the different types of tower silos. It is more difficult to get good estimates of the initial cost of trenches than for tower silos since they are far less uniform from farm to farm, much depending on local conditions. Despite this variability, however, there is little question that the initial investment is small comparatively.

Estimates were made of the initial cost of four different sizes of trenches with capacities roughly equivalent to the four sizes of tower silos examined in table 3. These cost estimates were based on the original cost of similar trenches among the 52 studied in the survey. The value of a farmer's time and the use of his equipment are included in these costs. Even if these estimates of initial costs are conservative, as has been suggested, the initial cost per ton is much lower than for any tower silo of equivalent capacity. Discrimination if made against trench silos must be based on something other than the amount of original investment.

TABLE 4. INITIAL INVESTMENT IN TRENCH SILOS
1955 - 1956

Size of trench	Capacity (tons)	Initial cost	Cost per ton of capacity
12 x 60 x 6	85	$ 63	$0.75
12 x 75 x 8	140	80	0.60
16 x 60 x 10	180	90	0.50
16 x 80 x 10	250	125	0.50

* Based on New York farmers' estimates.

The cost of installing a bunker type of silo consisting of a concrete slab and at least two sides of treated wood or other material, is at least as variable as the cost of installing trenches. Very few bunkers are currently in use although interest in this type of silo is quite great. The original investment will depend on the size of the bunker, the thickness of the concrete slab which is used as a base and the kind of sides made for the bunker. The very few accurate statements of original costs obtained indicate a range from $150 to $1000 for bunkers holding from 100 to 250 tons of silage.

Components of Costs in Storing Silage

Besides knowing how much different kinds of silos will cost initially, a farmer should have some idea of what his annual storage costs will be for each. Annual storage costs result largely from four different charges or costs. These are (1) depreciation and obsolescence, (2) interest on capital invested in the silo, (3) repairs and maintenance and (4) losses of silage from spoilage. Other items of cost might legitimately be included in the total if there were some good way to measure them. Chief among these is the loss of nutrients during the ensiling process. These losses vary considerably depending on the percent of water in the green material, original sugar content, amount of fiber, and general physical condition of the material when put into the silo. Physical conditions such as temperature and pressure, are also important. Differences in nutrient losses during the ensiling process which might be attributed to differences in the storage structures are thought to be relatively small. Since this study is primarily concerned with comparing storage costs in different types and sizes of silos, this particular cost or loss during storage was not included, because it does not affect actual differences that can be measured.

Procedure for Comparing Costs - To compare annual storage costs for different types of silos requires information in a different form than can be obtained directly from farmers. Because depreciation and interest make up more than half of annual costs, original investments in silos must be directly comparable for each size among the different types. As a result, budgets were prepared using the average of farmer's experiences to obtain rates of depreciation, repairs and maintenance, and losses from spoilage. Interest and depreciation were computed using 1955-56 silo prices obtained from manufacturers and dealers operating in New York.

Depreciation - Depreciation and obsolescence represent the decrease in value of an asset or investment due to wear, tear, or the fact that something new has outmoded the old. Most look at depreciation as a method of charging off the original investment in a durable asset over its useful life as an annual expense. The most difficult part in doing this job is choosing a reasonably accurate time period over which to spread depreciation.

Because we wish to compare the cost of storing silage in different types and sizes of silos the rates at which they are depreciated and their relative accuracy is especially important. Farmers' experiences provide the best information we have on length of life of different types of silos. Each farmer was asked to estimate how much longer each of his silos would last as well as when each silo was purchased. The present age of the silo plus this estimate of its future life were totaled and results for the group of farmers studied in 1954-55 are shown in table 5.

TABLE 5. ESTIMATED YEARS OF LIFE FOR DIFFERENT TYPES OF SILOS
(214 Silos, New York, 1954-55)

Estimated life of silo (years)	Wooden stave	Concrete stave	Glass-lined steel	Poured concrete	Trench
under 15	0	0	0	0	23
15-24	17	8	1	0	19
25-34	30	16	2	0	4
35-44	11	16	20	3	2
45-54	3	8	1	8	0
55 and over	0	3	0	19	0

More than half of the silos were less than ten years old. All of the glass-lined steel and all but one of the trenches were in this category. Farmers have had more experience with poured concrete, concrete stave and wooden stave towers on their own farms as well as observing how well they have lasted on their neighbors' farms. The strong concentration of opinion that steel glass-lined silos will last from 35 to 45 years is rather surprising. It may reflect some statements made by salesmen and the manufacturer, or may have been due to chance alone.

Using these results as guides the following years of life were chosen as most representative in charging depreciation:

Type of silo	Years
Treated white pine or spruce	30
Concrete stave	40
Glass-lined steel	40
Poured concrete	50
Unlined trench	10

All of these final estimates may be subject to challenge. However, they represent the best combination of judgment on this difficult subject that could be obtained using what evidence and experience was available.

Annual depreciation charges were computed using the straight line method. This assumes that an equal amount of the original value is used or lost every year. This seems to make as much sense in terms of cost to a farmer as any method. Once the silo has been erected on the farm its sale value is considerably less than its cost. Hence, any method of trying to reflect resale value through depreciation seems almost meaningless. Depreciation here provides a method of spreading an original investment over a period of years as an annual cost.

Interest - Interest was charged at the rate of five percent on one-half of the original cost of the silo. Such a charge is made to represent the cost of borrowing money to build a silo or the earnings such money might have produced if invested elsewhere. Five percent was considered a conservative rate for real estate. The choice of one-half the original value of the silo was made to facilitate comparisons without overemphasizing or ignoring the interest charge. If interest were charged on the full original value of the silo it would be applicable only during the first year of use. Likewise, it places the silo requiring a large original investment at a special disadvantage if comparisons are made on this basis only. Since interest charges decrease progressively during the useful life of a silo, an amount equal to the average over a period of years was chosen.

Repairs and Maintenance - Few silos require definite repairs or upkeep every year with the exception of wooden stave silos where hoops are tightened or adjusted annually or oftener. However, during the life of a silo painting the exterior or interior of the walls may occur one or more times and other small repairs are usually made to roofs, chutes or walls. Farmers, who provided basic information for this study, were asked to indicate the time spent, as well as the cost of materials used, or repairs made, in maintaining their silos over the last five years. Many had made no repairs during that time. This was especially true in the case of owners of glass-lined steel and poured concrete towers. Besides work on hoops, painting the exterior or interior of silos was frequently done.

The average annual charge for repairs and maintenance shown in table 6 indicates what a relatively small item this was in most cases. The average represents for each type of silo a combination of those who had no repairs over five years and some who had had expenses, a few of which were sizeable. When multiplied by the total number of years over which these silos are used these charges seem quite reasonable. No good reason was found for expecting a smaller amount of repairs on concrete stave silos than other towers except wooden staves. Hence, in the budgets the averages shown in table 6 were used with the exception of those for concrete stave silos. In this case an annual charge of $3 was also applied. Since no repairs or maintenance had been reported by users on the glass-lined towers no charge was budgeted. Problems and repairs had occurred in relation to the bottom unloaders

TABLE 6. AVERAGE ANNUAL CHARGE FOR REPAIRS AND MAINTENANCE (214 Silos, New York, 1954-55)

Type of silo	Number of silos	Average annual upkeep
Glass-lined steel	24	$0
Concrete stave	51	1
Poured concrete	30	3
Trench	48	3
Wooden stave	61	6

but not with the rest of the silo. The reported maintenance on unlined trenches was smaller than the authors had anticipated. However, a number of farmers indicated that they would dig another trench before putting much time or effort into an old one. No adjustments were made in the annual repair charge budgeted as size of silo increased.

Losses from Spoilage - The evaluation of silage lost because of spoilage was perhaps the most difficult factor to assess in determining annual storage costs. It was difficult to determine just how much silage had spoiled and was thrown away. Second, it was also difficult to say how much this spoiled silage had once been worth.

In the survey of farmers' experiences with their silos, the number of inches of spoilage on the surface, along the walls, and in the bottom of each silo were estimated by the owners. The number of cubic inches of spoiled silage in each of these areas was computed and converted into tons. Conversion factors used were 19 pounds per cubic foot on the surface, 43 pounds per cubic foot in the bottom and a sliding scale between these two along the walls for tower silos. The corresponding figures for trenches were 35 pounds per cubic foot on the surface, 38 pounds along the sides, and 40 pounds on the bottom.

The value of silage lost because of spoilage was figured at $7 per ton. Practically no market for corn and grass silage exists; hence, there are no standard prices. Costs of moving silage from one farm to another and then storing it prevent such a market from functioning. In terms of feeding value, three tons of silage are thought to be roughly equivalent to one ton of hay of similar quality. Since the average farm price of good quality hay in New York has been averaging $20 to $22 per ton during the past three years, the $7 price for silage was chosen based on its T.D.N. value in terms of hay.

The amount of spoiled silage reported for the different types and sizes of silos was quite variable. Those who fed silage year around had practically no losses. Some men with trenches lost almost half of their silage. These were the extremes but they illustrate the nature of the variation. Experience with grass silage was more variable than with corn in each of the types of silos. This is probably a result of many things, but important among them is the necessity of storing grass silage through the hot summer months before use in many cases, and the great variability in moisture content of the original material when filling silos.

TABLE 7. PERCENTAGE OF TOTAL TONS OF SILAGE WHICH SPOILED BY TYPE AND SIZE OF SILO (220 Silos, New York, 1954-55)

Type and size of silo	Number of silos	Percent of total tonnage which spoiled
Tile	12	1
Poured concrete		
Under 200 tons	21	2
200 and over	14	2
Concrete stave		
Under 100 tons	18	4
100 - 149	23	3
150 and over	11	2
Steel glass-lined		
Under 200 tons	14	4
200 and over	6	1
Wooden stave		
Under 60 tons	24	7
60 - 99	22	4
100 and over	15	3
Steel plate	13	9
Trench		
Under 75 tons	16	15
75 - 149	21	10
150 and over	15	10

When the total amount of silage which spoiled is expressed as a percentage of the total tonnage stored, such losses decrease as the size of silo increases. This was found to be generally true within each of the types of silos on which farm data were available, although numbers in each of the size groups within types were relatively small (table 7). These results are logical. As tower silos increase in diameter and height, the surface area decreases relative to the rest of the silo. If silage has been distributed and packed down properly, the amount subject to spoilage under normal circumstances does not increase as rapidly as total tonnage stored when successively larger silos are filled. This is not true with trenches. Maximum depth for most trenches is ten feet. Most are no more than 16 to 20 feet wide. Additional space is provided by extending the length of the trench. As a result surface spoilage does not decrease proportionally once maximum widths and depths have been achieved.

The following amounts of spoiled silage were budgeted as most likely to occur based on farmers' experience and general observations:

Size of silo	Conventional towers	Glass-lined steel	Trench
	(Percent of total tonnage spoiled)		
12 x 35 (84 tons)	4	-	15
14 x 40 (138 tons)	3	2	12
16 x 40 (180 tons)	2	1	10
16 x 50 (248 tons)	1	0.5	10

Budgeted Annual Storage Costs

Estimates of annual storage costs for different types of silos of the same size were made using the procedures and basic data just presented. Comparisons were then made between different types of construction at four different levels of rated capacity.

Silos with a Rated Capacity of 84 Tons - Tower silos with a 12 foot diameter are relatively common on New York farms. As more silage has been fed per cow and herds have increased in size, these smaller silos have decreased in importance. Annual storage costs for a 12 x 35 tower silo were budgeted as an example of the smaller silo which might be used to increase existing storage capacity. An unlined trench with dimensions of 12 x 60 x 6 will hold approximately 82 tons of silage based on an average weight of 38 pounds per cubic foot of silage. This is roughly comparable in capacity to the 12 x 35 tower.

Lowest cost storage in the smaller size of silo is provided by the monolithic, poured concrete type even though the original investment is as much as $125 greater than one of the other two types of tower silos. Perhaps of greater interest is the narrow range in annual storage costs for the four silos. The spread is $15, a relatively small difference in any one year, but of greater importance considered over 25 to 30 years or the minimum life of most tower silos. In the case of the three tower silos from 65 to 75 percent of annual costs were made up of depreciation and interest. In the case of the trench nearly 90 percent of the costs were represented by spoiled silage.

TABLE 8. ANNUAL STORAGE COSTS FOR SILOS WITH 84 TONS OF RATED STORAGE CAPACITY (Budget Data for New York Farms, 1955-56)

	Poured concrete (12 x 35)	Concrete stave (12 x 35)	Unlined trench (12 x 60 x 6)	Wooden stave* (12 x 35)
Original investment, 1955	$1407	$1344	$63	$1281
Storage costs:				
Depreciation	$ 28	$ 33	$ 6	$ 43
Interest	35	34	2	32
Repairs and maintenance	3	3	3	6
Losses from spoilage	24	24	88	24
Total annual cost	$ 90	$ 94	$99	$ 105
Cost per ton of rated capacity	$1.07	$1.12	$1.18	$1.24

* White pine or spruce.

Silos with a Rated Capacity of 138 tons - The 14 x 40 tower silo is probably more commonly sold than other sizes. It has a rated capacity of about 140 tons. All of the major manufacturers offer this size for sale. It is the smallest of the glass-lined steel silos and is very acceptable in size for wooden stave manufacturers where more height and larger diameters may cause problems.

TABLE 9. ANNUAL STORAGE COSTS FOR SILOS WITH 138 TONS OF RATED STORAGE CAPACITY (Budget Data for New York Farms, 1955-56)

	Poured concrete (14 x 40)	Concrete stave (14 x 40)	Unlined trench (12 x 75 x 8)	Wooden stave* (14 x 40)	Glass-lined steel (14 x 40)
Original investment, 1955	$1760	$1760	$ 80	$1690	$3484
Storage costs:					
Depreciation	$ 35	$ 44	$ 8	$ 56	$ 87
Interest	44	44	2	42	87
Repairs and maintenance	3	3	3	6	0
Losses from spoilage	29	29	116	29	20
Total annual cost	$ 111	$ 120	$129	$ 133	$ 194
Cost per ton of rated capacity	$0.81	$0.87	$0.92	$0.97	$1.40

* White pine or spruce.

The poured concrete silo has a cost advantage at this size of about $10 per year. This reflects primarily the expectation of a longer useful life. The wooden stave, concrete stave, and poured concrete silos are very competitively priced. The glass-lined steel silo has a high original cost, about twice that of other tower silos of the same size. This price does not include the cost of the bottom unloader which is a necessary additional piece of equipment. Since it is only used in removing silage from the silo, operating costs for this unloader were not included in annual storage costs.

There is a wider spread in annual storage costs among these five silos (14 x 40's) than for the smaller ones (12 x 35's). In all cases the cost per ton of rated capacity was lower for these larger silos than the equivalent smaller sizes. Depreciation and interest make up from 70 to 90 percent of storage costs in all of the tower silos while losses from spoilage is the big item in storage costs for trenches.

Silos with a Rated Capacity of 180 tons - A 16 x 40 silo was not very common 20 years ago. Today they are much more widely used on commercial farms. Glass-lined steel towers of this size are not made. The 17 x 40, which has a rated capacity of a little over 200 tons, was used for purposes of comparison with the other silos holding 180 tons.

TABLE 10. ANNUAL STORAGE COSTS FOR SILOS WITH 180 TONS OF RATED STORAGE CAPACITY
(Budget Data for New York Farms, 1955-56)

	Poured concrete (16 x 40)	Concrete stave (16 x 40)	Unlined trench (16 x 60 x 10)	Wooden stave* (16 x 40)	Glass-lined steel (17 x 40)
Original investment, 1955	$2025	$2070	$ 90	$1935	$4131
Storage costs:					
Depreciation	$ 40	$ 52	$ 9	$ 65	$ 103
Interest	51	52	2	48	103
Repairs and maintenance	3	3	3	6	0
Losses from spoilage	25	25	126	25	14
Total annual cost	$ 119	$ 132	$140	$ 144	$ 220
Cost per ton of rated capacity	$0.66	$0.73	$0.78	$0.80	$1.08

* White pine or spruce.

There is a spread of $25 in annual storage costs between poured concrete and wooden stave silos of this size with concrete stave and trenches falling between these two in costs. Glass-lined steel towers are considerably more expensive initially and this high original cost is reflected in depreciation and interest. The storage cost per ton of rated capacity likewise favors poured concrete and concrete stave silos. As was true in the previous cases, storage costs per ton continue to decrease for all of the different types of silos as the size of silo is increased from 138 to 180 tons.

Silos with a Rated Capacity of 248 tons - Large silos with diameters of 16 or more feet and heights of 50 feet or more are being used on a number of farms. As yet they are not common. However, it is likely that they will increase in numbers on large commercial farms. Wooden stave silos of this size are not sold in most cases. Poured concrete silos are more frequently found. Trenches, which will hold the equivalent of 250 tons of silage, are about as deep and wide as they are commonly dug. Additional tonnage is obtained by extending their length.

TABLE 11. ANNUAL STORAGE COSTS FOR SILOS WITH 248 TONS OF RATED STORAGE CAPACITY (Budget Data for New York Farms, 1955-56)

	Poured concrete (16 x 50)	Concrete stave (16 x 50)	Unlined trench (16 x 80 x 10)	Glass-lined steel (20 x 40)
Original investment, 1955	$2356	$2790	$125	$5428
Storage costs:				
Depreciation	$ 47	$ 69	$ 12	$ 135
Interest	59	70	3	136
Repairs and maintenance	3	3	3	0
Losses from spoilage	18	18	174	10
Total annual cost	$ 127	$ 160	$192	$ 281
Cost per ton of rated capacity	$0.51	$0.64	$0.78	$0.99

Differences in storage costs for these large silos are more pronounced. The poured concrete tower has a definite cost advantage over all the others, both in terms of original investment and annual storage costs. The concrete stave tower, likewise appears to be definitely more economical to use than a trench or glass-lined steel tower. The 20 x 40 glass-lined steel silo has a rated capacity of 282 tons, but this additional size does not reduce the annual storage cost per ton enough to make it competitive on a cost basis.

Summary of Storage Costs per Ton for Different Types and Sizes of Silos

The analysis of storage costs for different sizes of the more common types of silos can perhaps be summarized most effectively with a chart or graph. The budgeted storage cost per ton of rated capacity for each of the different types of silos is shown in figure 1. Basic data for these curves were obtained from tables 8-11.

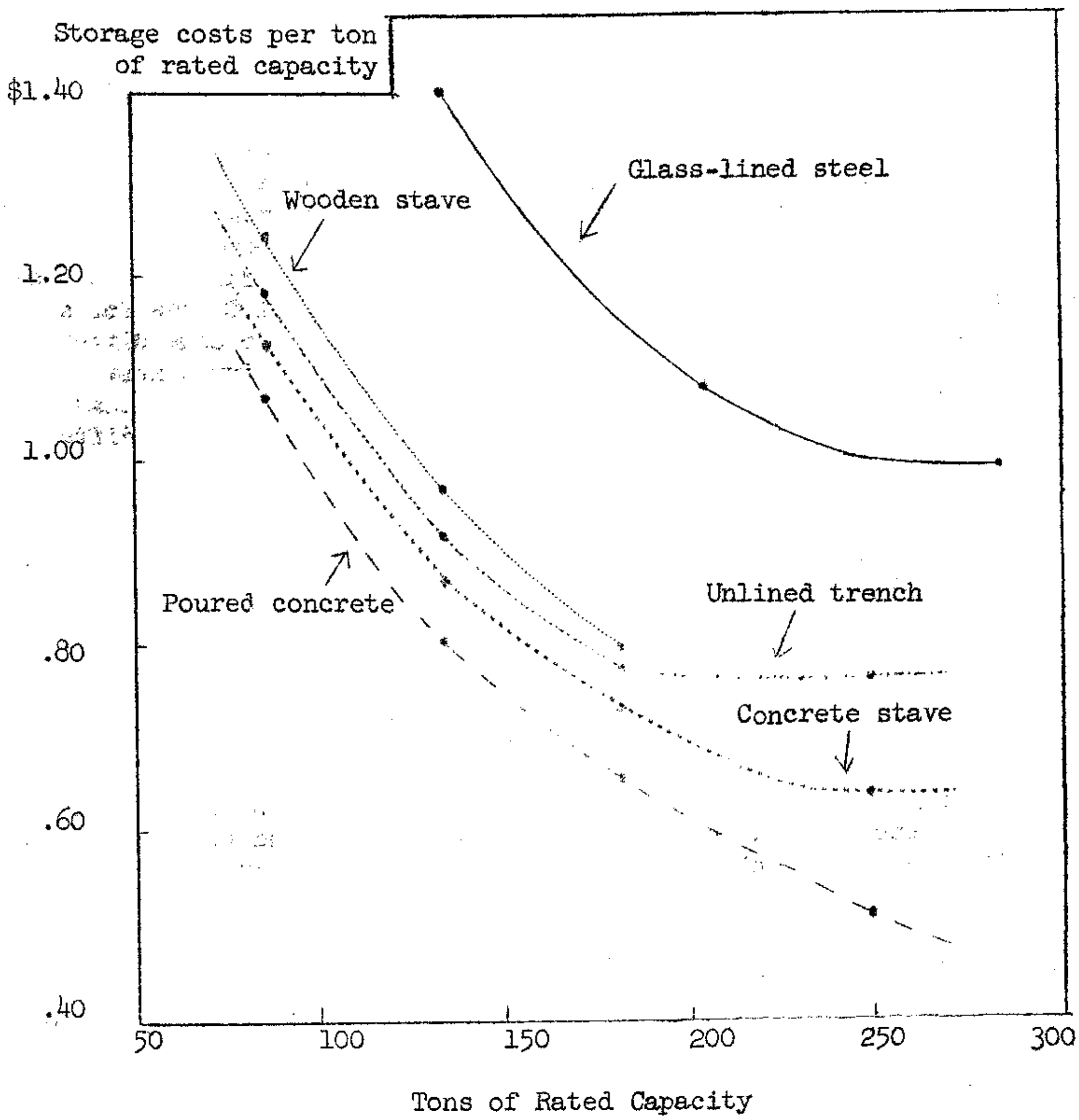

FIGURE 1. COMPARISON OF ANNUAL STORAGE COSTS PER TON OF RATED CAPACITY FOR DIFFERENT TYPES OF SILOS (Budget Data for New York Farms, 1955-56)

In all cases storage costs per ton decreased as the size of silo increased. One might also expect further decreases in costs per ton, resulting from increasing the size of silo, to be small after reaching capacities of 250 to 300 tons. The fact that wooden stave silos are not available in these larger sizes indicates that some structural problems arise and that further increases in size might actually raise storage costs per ton.

At all sizes the poured concrete tower silo had a cost advantage. For the smaller silo this advantage was not large. However, as size of silo increased this cost advantage per ton also increased. If capacity for more than 200 tons of silage were desired and a poured concrete silo could be obtained, the economic advantage here is clear-cut.

In evaluating these differences in costs per ton between types of silos, the question of the importance of the small differences can not be ignored. Are they significant? Because they are based on budgets which involve many necessary assumptions there may be additional reasons to raise questions. However, these budgets provide the best method we have of making comparisons under the same kind of circumstances. The smallest difference noted was five cents per ton between poured concrete and concrete stave silos for the smallest size studied. This five cents per ton multiplied by 150 tons for a 30 year period amounts to $225. Viewed in this manner the five cent difference has a little more significance. Since silos are long time investments, the estimate of total storage costs during most of the life of a silo seems a valid method of interpreting these comparisons. Hence, the $0.13 difference in storage costs per ton between concrete stave and poured concrete silo with rated capacities of about 250 tons amounts to $1300 over a 40 year period.

Rated on an annual storage cost basis, the five types of silos rank in the following order:

(1) Poured concrete
(2) Concrete stave
(3) Unlined trench
(4) Treated pine or spruce stave
(5) Glass-lined steel.

This ranking holds true for all sizes where these types of silos are competitive with each other. Insofar as the assumptions and farm data used in these budgets are reasonable and correct, these results are meaningful.

Effect of the Price of Silage on Storage Costs

Farmers, who are often short of roughages or must buy hay if crops of corn and grass are short, value a ton of silage more highly than those who commonly produce more forage than they can feed on their farms. Since the value of silage lost from spoilage is a very important factor in determining storage costs, this difference in outlook cannot be overlooked. The ranking of tower silos on the basis of storage costs is not affected by changing the price of silage. However, the competitive position of unlined trenches with the different types of tower silos is changed when the value of silage, which is lost from spoilage, is increased or decreased.

To demonstrate the kinds of changes which occur, budgets using a $5 and $10 price per ton for silage were prepared in computing annual storage costs per ton for the different types of silos. The $5 price more nearly reflects the position of a farmer with large supplies of roughage and a relatively poor market for hay. The $10 price approximates the position of a farmer who is usually in short supply of roughages.

TABLE 12. ANNUAL STORAGE COSTS PER TON OF RATED CAPACITY WITH SILAGE VALUED AT $5 PER TON (Budget Data, New York Farms, 1955-56)

Type of silo	Annual storage cost per ton for: 84 tons	138 tons	180 tons	248 tons
Unlined trench	$0.88	$0.68	$0.58	$0.58
Poured concrete	0.99	0.74	0.62	0.49
Concrete stave	1.04	0.80	0.69	0.62
Wooden stave	1.16	0.90	0.76	-
Glass-lined steel	-	1.36	1.07	0.98

Because losses from spoilage are the principal cost item for unlined trenches, while interest and depreciation are the major ones for the tower silos, the unlined trench becomes the lowest cost method of storage when silage is valued at $5 per ton (table 12). This is true until about 200 tons of capacity is reached. Then the poured concrete tower provides lower storage costs per ton. At 250 tons of capacity the concrete stave silo is also more competitive.

TABLE 13. ANNUAL STORAGE COSTS PER TON OF RATED CAPACITY WITH SILAGE VALUED AT $10 PER TON (Budget Data, New York Farms, 1955-56)

Type of silo	Annual storage costs per ton for: 84 tons	138 tons	180 tons	248 tons
Poured concrete	$1.19	$0.90	$0.72	$0.54
Concrete stave	1.24	0.96	0.79	0.67
Wooden stave	1.36	1.06	0.86	-
Glass-lined steel	-	1.46	1.12	1.02
Unlined trench	1.63	1.28	1.08	1.08

When a higher price is placed on silage, the unlined trench is less desirable as a method of storing silage. It provides more expensive storage per ton than any of the tower silos except glass-lined steel. And even then, in the largest sizes the glass-lined steel tower provides lower cost storage. When roughage is likely to be in short supply or relatively high in price, an unlined trench is a high cost method of storing silage.

Effect of Variability in Amounts of Spoilage on Storage Costs

The amount of silage which could be expected to spoil under "average conditions" in each of the types of silos was estimated using farmers' experiences as a guide. These estimates were used in computing storage costs for the preceding comparative analysis. Actual variability in the amount of losses from spoilage on the farms studied was high. Hence, it can be argued that the losses budgeted for trenches are not representative for those farmers who have excellent management ability or for the size of losses expected under optimum conditions. This is undoubtedly true. However, storage costs for all of the types of silos consciously were estimated under "average" rather than "optimum" conditions for general application.

In appraising the feasibility of unlined trenches on a cost basis it may be helpful to determine what percentage of total silage stored could spoil and still have storage costs comparable to those for a poured concrete silo. Such calculations were made pricing silage at $7 per ton.

Size of silo	Original estimates of percentage of stored silage which spoiled in unlined trenches	Percent spoilage making storage costs comparable with poured concrete silos
(tons)	(percent)	(percent)
84	15	13
138	12	10
180	10	8
248	10	6

Reducing the amount of spoiled silage by two to four percent of the total amount stored will make storage costs in trenches comparable with poured concrete silos. This means reducing actual spoilage from 10 to 40 percent depending on the size of trench. Some farmers reported that less than 10 percent of the silage in their trenches had spoiled. Losses can be this small. However, most would agree that the risk of a high rate of spoilage is greater in trenches than in conventional towers.

THE TOTAL COST OF STORING AND HANDLING SILAGE

Associated with differences in the cost of storing silage in different sizes and types of silos may be differences in the amount of labor needed or used in getting silage from the field into storage and then out again for feeding. How great are the advantages in the use of labor for any particular method of storage? This question was approached by obtaining information on the amounts of labor used in filling, unloading and then feeding silage from the farmers who provided basic cost data on their silos.

Kinds of Information Obtained on Labor Use

Each farmer indicated his best estimates of all the labor used in handling silage. This was divided into three major operations: - filling, unloading and feeding. Labor for silo filling included the man hours used in harvesting silage in the field, transporting it to the silo and then blowing it inside and packing it down. Unloading consisted of the man hours spent in climbing up and down the silo and throwing out silage to an assembly point prior to feeding. Labor for feeding included time spent moving silage from the base of a silo or similar point to the cows manger. All of the labor used getting silage from the field to the cow was included insofar as possible.

TABLE 14. AMOUNT OF TIME SPENT HANDLING SILAGE BY TYPE AND SIZE OF SILO (201 Silos, New York State, 1954-55)

Type and size of silo	Number of silos	Average hours per ton			
		Filling	Unloading	Feeding	Total
Poured concrete					
Under 200 tons	21	0.8	0.8	1.0	2.6
200 and over	14	0.7	0.5	0.7	1.9
Concrete stave					
Under 100 tons	18	0.8	0.8	0.9	2.5
100 - 149	23	0.7	0.6	0.7	2.0
150 and over	10	0.5	0.5	0.9	1.9
Wooden stave					
Under 60 tons	23	1.4	0.8	1.2	3.4
60 - 99	22	1.0	0.8	1.0	2.8
100 and over	15	0.6	0.6	0.8	2.0
Glass-lined steel					
Under 200 tons	11	0.9	0.7	0.8	2.4
200 and over	6	0.7	0.6	0.5	1.8
Unlined trench					
Under 75 tons	15	1.7	1.2	0.5	3.4
75 - 149	19	0.8	0.9	0.6	2.3
150 and over	14	1.2	0.7	0.2	2.1

Labor Used in Handling Silage

The man hours of labor used per ton of silage handled by types and sizes of silos are shown in table 14. In all three of the major operations there was more variation among farms within each type of silo than between types. The size of the silo within each class was the most important factor determining the amount of labor used in handling silage.

The hours of labor used in filling a silo are certainly affected by the type of equipment used in the field and at the silo. There was usually more and better equipment available for silo filling on the farms with large silos. This is partially reflected in the averages shown in table 14. However, most farmers with tower silos were using from 0.6 to 1.0 hour per ton to fill them if they held at least 100 tons of silage. Filling trenches did not require a blower if a field chopper was used. However, large trenches required constant packing with a tractor of some type. Unlike the other types of silos there was an increase in the amount of labor used per ton for filling trenches holding over 150 tons.

Time spent in unloading tower silos was fairly consistent and comparable for each of the types. The advantage shown when unloading the larger tower silos is undoubtedly related to the number of cows fed and the amount of silage handled each trip into the silo. There appeared to be no advantage in unloading a trench silo compared to the towers. In fact the trenches showed at something of a disadvantage. Some of this arose from the need to separate spoiled material from the good silage.

Feeding labor was also quite comparable among the different types of tower silos. The larger silos and larger herds in general led to more efficient methods of getting silage to the cows. But this was not always true. Here again, it seems logical to expect that other factors than the type of tower silo were most important in determining differences from farm to farm in the amount of time spent per ton in feeding silage. There appeared to be a definite advantage in favor of trenches in getting silage to the cows. This was partly true because a sizeable number of trenches were used along with outdoor feeding bunks or loose housing systems.

TABLE 15. THE RELATIONSHIP BETWEEN TONS OF SILAGE HANDLED PER SILO AND HOURS SPENT PER TON (236 Silos, New York State, 1954-55)

Tons of silage handled per silo	Number of silos	Man hours per ton
Under 60	49	3.4
60 - 99	62	2.7
100 - 139	54	2.3
140 - 179	29	2.1
180 - 219	23	1.9
220 and over	19	2.2

The total amount of time used in handling a ton of silage on most farms ranged between one and three hours. On 10 percent of the farms however, four or more hours per ton were required. Nearly all of these farmers had small silos, either trenches or wooden stave towers. When silos were grouped by the number of tons of silage handled, regardless of the type of structure, a definite relationship with hours of time spent in handling each ton of silage is demonstrated.

Estimates of the Cost of Storing and Handling Silage

Analysis of the data obtained from farmers on labor used in handling silage indicated that there were no clearly measurable differences between the different types of tower silos of the same size. Slightly more labor per ton was used by those with unlined trenches. But even this difference was small and not clear cut. There was demonstrated, however, a definite relationship between size of silo, regardless of type, and hours spent per ton in handling silage. This labor efficiency added to that demonstrated already for storage costs increases the economic advantage of the large silo over smaller units.

Basic Data for Budgets - To show the nature of differences between different types and sizes of silos when both labor for handling and storage costs are considered, estimates of the total hours commonly used in handling a ton of silage were prepared, based on farm survey data:

TABLE 16. ESTIMATED HOURS SPENT IN HANDLING ONE TON OF SILAGE (Budget Data, New York Farms, 1955-56)

Size of silo	Poured concrete	Concrete stave	Wooden stave	Glass-lined steel	Unlined trench
(tons)			(hours per ton)		
84	2.6	2.6	2.6	-	2.8
138	2.4	2.4	2.4	2.4	2.6
180	2.0	2.0	2.0	2.0	2.2
248	2.0	2.0	-	2.0	2.2

Handling time in the different types of tower silos was thought to be similar enough so that no differences were shown (table 16). The decrease in hours spent per ton with increases in size roughly approximate those shown in table 15. The disadvantage of 0.2 hours per ton at all size levels for trenches was based primarily on the evidence obtained from farmers rather than on specific, logical grounds. While some users of trench silos look upon them as labor saving devices, there was no evidence to support that idea in this study of silos on commercial dairy farms.

Total Costs per Ton - The total cost of storing and handling silage in the different types and sizes of silos was determined by adding together storage costs per ton and a charge for labor used. A rate of $1.00 per hour was applied to the estimates for handling labor shown in table 16. In most cases labor made up from two- thirds to three-fourths of the resulting totals.

TABLE 17. TOTAL STORAGE AND HANDLING COSTS PER TON OF SILAGE (Budget Data, New York Farms, 1955-56)

Size of silo (tons)	Poured concrete	Concrete stave	Wooden stave	Glass-lined steel*	Unlined trench
			(cost per ton)		
84	$3.53	$3.58	$3.70	-	$3.63
138	3.14	3.20	3.30	$5.72	3.38
180	2.66	2.73	2.80	4.51	2.98
248	2.58	2.71	-	4.12	2.98

* Costs of operating bottom unloaders to remove silage are included in the totals for glass-lined steel towers.

Combining storage costs with a charge for labor changes the relative ranking of the different types of silos on a cost basis only slightly. For all sizes except the smallest capacity silo budgeted, the wooden stave now has some advantage over the unlined trenches. Poured concrete and concrete stave towers still provide the lowest cost storage at all sizes.

The competitive position of the glass-lined steel silos is made less desirable when the cost of operating bottom unloaders is included in storage and handling costs (table 17). Operating costs for 19 such unloaders averaged $1.69 per ton of silage removed on farms studied in the original survey. Depreciation made up about 50 percent of total costs while repairs and maintenance were also a big item - 25 percent of the total. Annual costs for operating bottom unloaders in the glass-lined steel towers were estimated based on these farmers' experiences. They were:

Size of silo	Operating cost per ton
14 x 40	$1.92
17 x 40	1.43
20 x 40	1.03

Some farmers also use surface unloaders in their tower silos. These, of course, are not necessary to get silage out of the silo, but like the bottom unloaders in the glass-lined steel silos, save physical effort in handling silage. If such surface unloaders are used in conventional towers from $.75 to $1.25 per ton will be added to handling costs depending on the size of silo.

FARM DECISIONS ON STORING SILAGE

With some basic information available on the cost of storing and handling silage in different types and sizes of silos, a farmer should be in a better position to determine what kind of silo will best meet his needs. However, cost information provides only a part of what he needs to know. Before putting up a silo such things as the amount of roughage that can be produced on the farm, the amount of silage needed for present livestock and expected changes in their numbers, and current storage facilities must be considered. The availability of different kinds of silos and local price relationships are important. Likewise, a man's capital position, tenure, and age cannot be ignored.

Each of the types of silos has some special advantages and limitations. The permanent tower silos have high initial construction costs, but they have the advantages of low rates of spoilage, good appearance, and generally can be located conveniently for filling and feeding. In contrast, unlined trenches have a very low construction cost, and hence, silo capacity can be increased easily. Filling is easy and inexpensive, and feeding is efficient if done in outdoor bunks. However, a high percentage of silage is often lost because of spoilage. A good site is needed for both drainage and efficiency since unloading and feeding are done out-of-doors, the bottom and access may get muddy, and feeding is often inefficient if silage is barn fed.

Each farmer must decide for himself the amount of silage he will feed per animal. However, if there is no good basis for estimating feeding rates from past experience, a reasonable range to use in calculating storage capacity needed for a dairy herd is from five to seven tons for each cow and her replacement. The figure of six tons suggested here is based on present New York cost account records and expected increases in feeding rates.

The trend in dairy farming today is toward fewer and larger commercial dairy farms. This in turn means that in the long run each farm will have need for more silage storage capacity. A set of problems will be examined to point out how one may determine the best type and size of silo to use under different conditions to obtain additional storage capacity.

Consider the case of a farmer with 20 cows who has enlarged his milking herd to 30 cows over the past five years and is now short of silage. He plans to continue dairy farming as a livelihood, and expects to increase his herd to about 40 cows and accompanying young stock. There are 80 acres of good cropland besides 100 acres of non-tillable pasture and hay meadows on the farm. He now has a 14 x 40 wooden stave silo which is in poor condition and must be replaced in the near future. What kind and size of storage facilities should he provide?

The silage requirements for 40 cows and their replacements based on assumed needs of six tons of silage per milking cow are 240 tons. Lowest cost storage is provided by poured concrete towers. Hence, they should be considered first if they are available in the area. If not, a concrete stave silo generally will provide storage at the next lowest cost per ton.

The 250 tons of capacity can be obtained with several different storage patterns such as one upright, two uprights, one upright and a trench, or one trench silo. For example, he could buy 276 tons of storage capacity with the use of two 14 x 40 poured concrete silos for a total initial cost of $3520 in 1956. He could also buy one large 16 x 50 silo which will provide 248 tons of rated capacity for $2356. Since he is making a long-run capital improvement and is somewhat short of cropland, a trench silo would not be as feasible on this farm as one large tower. The initial capital efficiencies made possible with the use of trenches are not so important in long-run planning because the fixed costs, (depreciation and interest), are spread over a large number of production periods and risk of losses from spoilage are reduced.

Now, if this same farmer had had a 14 x 40 concrete stave silo which had been built 10 years ago and was still in good condition, he would look at his situation a little differently. One alternative would be to build another 14 x 40 poured concrete silo for $1760. He would then have 276 tons of storage capacity. On the other hand, he could put up a 12 x 35 poured concrete silo, with only 87 tons of capacity, which would give him a total of 225 tons of storage capacity. If necessary, he could obtain additional storage capacity by double use of one of the silos. This latter alternative, adding a 12 x 35 silo, would require an initial outlay of $1407. However, storage costs per ton might be reduced on the old silo if more tons of silage were processed through it. This would depend on the availability and need for grass silage. In comparing these two alternatives, this farmer would have to decide whether the additional capacity of 51 tons obtained by building a 14 x 40 silo is worth the extra initial outlay of $353 and succeeding annual costs. This extra capacity can serve as a storage reserve for forage crops when yields are considerably above average. In general, it pays to have storage capacity great enough to hold more than an average silage yield but not large enough to hold the best yield possible. It may be most economical in the long run to add some additional capacity at the time of construction to take care of nearly all expected storage needs.

If this farmer expected to change farms or retire within the next five years but needed additional storage now, a trench silo might be used to advantage if he has a reasonably good site. The trench silo offers considerable flexibility because of its low initial investment. It may be especially useful for dairy farmers with limited economic expectations because of old age, limited tenure, poor financing, and small, unproductive farms. The trench has its greatest advantage in these short-run situations since the fixed depreciation and interest costs are minimized. The importance of the loss of several acres of cropland because of heavy spoilage losses in trench silos should also influence a decision of whether or not to use them. When a trench is used in combination with a tower silo, spoilage can be reduced somewhat by opening and feeding silage from the trench first.

Analyzing Silage Needs and Storage Costs

To aid in analyzing individual needs, original construction costs, and resulting storage costs, a simple worksheet was developed for use in comparing alternative ways of storing silage. An example is provided to indicate how costs can be examined on an individual farm and what calculations are necessary. A table for estimating the size of tower silo needed to provide a given capacity of silage follows this worksheet. The silage table is conservative. In most cases a somewhat greater tonnage of good quality silage will be stored than the table indicates.

BUDGETING SILAGE NEEDS AND STORAGE COSTS
(Take Time to Look at Your Alternatives Before you Buy)

CAPACITY NEEDED:

Example:		Your Farm:	
cows 40 x 5 tons per cow	= 200	cows ____ x ____ tons per cow	= ____
heifers 20 x 2 tons per heifer	= 40	heifers ____ x ____ tons per heifer	= ____
Average capacity needed	= 240	Average capacity needed	= ____
Present capacity	= 0	Present capacity	= ____
New capacity needed	= 240	New capacity needed	= ____

SIZE OF SILO:

Example: Tower for 240 tons = 16 x 50 or 18 x 45
Trench for 240 tons = 16 x 80 x 10 based on 38 lbs. of silage per cubic foot.

Your Farm: Tower for ____ tons = ________________
Trench for ____ tons = ________________

COMPARISON OF CONSTRUCTION COSTS:

	Example	COST OF LOCAL ALTERNATIVES #1	#2	#3
Roof	$ 300			
Walls and chute	2100			
Foundation	190			
Putting up silo	200			
Other	--			
Total cost erected	$2790			

COMPARISON OF ANNUAL STORAGE COSTS:

	Example	#1	#2	#3
Depreciation	$ 69			
Interest	70			
Repairs and maintenance	3			
Spoilage	18			
Total storage costs	$160			

MAKING ESTIMATES OF ANNUAL STORAGE COSTS:

Depreciation: Estimate years of life for silo and divide into construction cost.

Interest: Multiply one-half of original cost by 5% interest rate.

Repairs: Use some constant annual charge; from $2 to 10 suggested.

Spoilage: Use percent of total tonnage for each type of silo as reported on page 11. Multiply by capacity of silo and by price of $7 per ton. Vary to meet your management and local conditions.

SILAGE TABLE: APPROXIMATE CAPACITY OF CYLINDRICAL SILOS
(Use height of silage after settling two days)

Depth of silage (feet)	Inside diameter of silo, in feet: 10	12	14	16	18	20	Mean weight per cubic foot (pounds)
	(tons)						
1	1	1	1	2	2	3	18.7
2	2	2	3	4	5	6	19.6
3	2	3	5	6	8	9	20.6
4	3	5	7	9	11	13	21.2
5	4	6	9	11	14	17	22.1
6	5	8	11	14	17	21	22.9
7	7	9	13	17	21	25	23.8
8	8	11	15	20	25	31	24.5
9	9	13	18	23	29	36	25.3
10	10	15	20	26	33	41	26.1
11	12	17	23	30	38	46	26.8
12	13	19	25	33	42	52	27.6
13	14	21	28	37	47	58	28.3
14	16	23	31	41	52	64	29.1
15	18	25	34	45	57	70	29.8
16	19	28	38	49	62	77	30.5
17	21	30	41	53	67	83	31.2
18	23	32	44	58	73	90	31.9
19	24	35	48	62	79	97	32.6
20	26	38	51	67	85	105	33.3
21	28	40	55	72	91	112	33.9
22	30	43	59	77	97	120	34.6
23	32	46	63	82	103	128	35.3
24	34	49	66	87	110	135	35.9
25	36	52	70	92	116	143	36.5
26	38	55	74	97	123	152	37.2
27	40	58	79	103	130	160	37.8
28	42	61	83	108	137	169	38.4
29	44	64	87	114	144	178	39.0
30	47	67	91	119	151	187	39.6
31	49	70	96	125	158	195	40.1
32	51	74	100	131	166	205	40.7
33	53	77	105	138	173	214	41.2
34	56	80	109	143	181	224	41.8
35	58	84	114	149	188	232	42.3
36	61	87	118	155	196	242	42.8
37	63	90	123	161	204	252	
38	66	94	128	167	212	262	
39	68	97	133	174	221	272	
40	70	101	138	180	229	282	
41	72	105	143	187	236	291	
42	74	109	148	193	244	300	
43		113	154	201	252	310	
44		117	159	207	261	320	
45	82	121	165	215	269	330	
50	94	137	186	248	310	382	
55		155	212	283	365	444	
60			240	319	415	500	