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Silage Making COSTS and PRACTICES

Report of a 1954-55 Study of Experiences of Farmers in Four Alabama Counties

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Silage Making COSTS and PRACTICES*

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HOW MUCH DOES IT COST to make silage? That is a big question facing farmers who want to include silage in their feeding programs. And, it is a difficult one to answer because of wide variation in silage making practices, equipment, and storage facilities used, and different silage crops grown.

Several other factors are important in determining if silage production is profitable on a given farm. Among these are (1) kind of livestock produced and level of production; (2) availability and cost of other feeds; (3) availability of men and machines needed to make silage; (4) whether to buy, hire, or trade for machines and labor; and (5) kind and size of silo to build. However, only cost of harvesting, storing, and feeding silage is considered in this report.

A useful way of expressing silage costs is in terms of the cost per ton harvested. To harvest silage, men and machines are organized

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**Farm Economics Research Division, Agricultural Research Service, U. S. Department of Agriculture.

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into operating units. Forage is cut, loaded, hauled to the silo, and unloaded. In performing these operations, costs are incurred. Total costs will be high or low depending on several factors, one of which is how well the operation is organized. In addition to organization of the operating unit, yield per acre, field conditions, and kind and size of machines used also affect costs per ton of harvesting silage.

Farmers have immediate control over two general factors that primarily determine costs per ton of making silage. These are the speed of harvesting or the tons of silage harvested per hour, and the kind and number of machines and men used or the hourly operating cost. Generally speaking, as more men and machines are used, more silage can be harvested per hour. However, hourly operating costs also increase, so that the cost per ton may not always decrease as more tons are harvested per unit of time. The object is to have the number and kind of machines and men that will enable silage of good quality to be made at the lowest cost per ton.

PROCEDURE

To determine silage making costs, a cooperative project was conducted by the Agricultural Experiment Station of the Alabama Polytechnic Institute and the Farm Economics Research Division, U. S. Department of Agriculture. Silage operations on 71 farms in one of the Limestone Valley areas of Alabama were studied during 1954-55. Practices used to harvest, store, and feed silage were studied and costs were computed for each operation.

Four counties — Calhoun, Talladega, St. Clair, and Shelby — were selected for study because they met the following criteria: (1) prevalence of farms on which silage was made; (2) a variety of ensiled crops, including corn and grass-legume mixtures; and (3) family size livestock farms. A complete enumeration of all farms making silage in these four counties from June 1954 through May 1955 was attempted. These farmers were contacted for data on their experiences in harvesting, storing, and feeding silage.

DESCRIPTION of FARMS

Ninety-four per cent of the farms studied had dairy herds and 20 per cent had beef herds. Cotton was grown on 18 per cent of the farms with an average cotton acreage of 21 acres.

Corn was the most common silage crop grown and crimson clover-grass was second. (See Appendix Tables 1 through 6 for details on farm organizations.)

Farms having upright silos were larger than those using trench silos in most respects. This was particularly true for such items as size of farm, cropland acres, and livestock numbers. Field forage harvesters were used on the larger farms.

Most of the farmers made silage only once during the year. However, 15 per cent made silage both in spring and fall. A greater percentage of farmers using upright silos made silage twice during the year than did farmers using trench silos.

One-fifth of the farmers had no previous experience in making silage, and more than half of them had less than 3 years' experience. Farmers using trench silos generally had less experience than had those using upright silos. Grass-legume silage was more popular with farmers who had added silage to their feed programs recently than with those who had made silage for several years. About 75 per cent of the farmers making grass silage had less than 3 years' experience.

Field forage harvesters were the most common type of harvesting machine used. Binders were the next most common and a few farmers used mowers. Binders were used primarily by those who had been putting up silage for several years; whereas, 85 per cent of the farmers who made silage for the first or second time used field forage harvesters.

Fifty-four per cent of the farmers using field forage harvesters owned their machines, 35 per cent hired the work done, and 11 per cent swapped work with their neighbors. A higher percentage of farmers owned the binders used, and only one farmer hired the use of a binder.

Four answers accounted for more than half of the replies to the question, "Why did you start making silage?" These were (1) saw others doing it, (2) could obtain cheaper feed or milk, (3) needed more feed, and (4) drought of 1954 reduced forage growth. Farmers were also asked why they chose the particular day on which they made silage. Condition of the crop was the determining factor in a majority of the cases. Many replied that they cut forage early because of drought.

Only five farmers reported that silage making conflicted with other work on the farm. Five farmers reported difficulty in getting

labor to make silage; four had difficulty in getting field forage harvesters when needed; and one found it difficult to rent a tractor when it was needed. Aside from these 10 farms, no difficulties were reported in getting the men and machines wanted at the time needed.

HARVESTING PRACTICES and COSTS

Harvesting costs were determined by multiplying the number of hours spent making silage by a cost per hour figure for the various machines and men used. The cost per hour for various machines is shown in Table 1. Hourly costs include the use of small, medium, or large tractors depending on the equipment used. Tractor size indicated in Table 1 was determined from the practices used by a majority of farmers in the study. If different sized tractors are used, hourly costs will change.

TABLE 1. ESTIMATED AVERAGE COST PER HOUR OF OPERATING MACHINES TO MAKE SILAGE, 4-COUNTY AREA, ALABAMA, 1954-55[1]

Operation or kind of equipment	Tractor size	Hourly tractor cost			Hourly cost for equipment	Total cost per hour for tractor and equipment
		Fixed cost	Fuel	Total		
		Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Field forage harvester	Large	0.54	0.54	1.08	1.40[2]	2.48
Binder	Medium	.45	.32	.77	.38	1.15
Mower	Small	.39	.25	.64	.42	1.06
Cutter	Large	.54	.49	1.03	.44	1.47
Blower	Large	.54	.35	.89	.35	1.24
Wagon	Small	.39	.25	.64	.04	.68
Buckrake	Large	.54	.54	1.08	1.14	2.22
Pack	Medium	.45	.26	.71		.71
Truck			.40[3]		.50	.90

[1] For more detail on costs and methods used in their calculation see Appendix Table 10.

[2] Cost for field forage harvester with either grass or row crop attachment. If machine had both attachments, the hourly cost would be $1.66.

[3] Fuel and oil costs for truck.

The average cost of harvesting silage for the 87[1] operations was $2.73 per ton. Sixty-two per cent of this cost was for machine use, 37 per cent for labor, and 1 per cent for extra packing and preservative. Harvesting costs were higher for silage put in upright silos

[1] Some farmers made silage more than one time during the year.

than for that placed in trench silos, Table 2. Therefore, comments will be made separately for trench and upright silos.

TABLE 2. COMPARATIVE AVERAGE COSTS PER TON OF HARVESTING AND STORING SILAGE IN TRENCH AND UPRIGHT SILOS, 87 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Item	Trench	Upright	All silos
	Dol.	*Dol.*	*Dol.*
Machine cost	1.51	1.98	1.65
Labor cost	.88	1.40	1.04
Extra packing	.01	.02	.01
Preservative	.03	.04	.03
TOTAL	2.43	3.44	2.73

As the number of men and machines needed for the harvesting operation depends mainly on the kind of machine used to cut the forage, the data were grouped according to method of cutting. Field forage harvesters were used for 67 per cent of the operations, binders for 18 per cent, mowers for 13 per cent, and hand cutting (corn) for 2 per cent.

For similar yields and field conditions, silage was harvested with the least average cost when field forage harvesters were used, Table

TABLE 3. AVERAGE COSTS PER HOUR AND PER TON OF HARVESTING SILAGE BY TYPE OF SILO AND BY METHOD OF CUTTING SILAGE, 87 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Type of silo and method of cutting silage	Average cost per hour			Average cost per ton		
	Machine	Labor	Total[1]	Machine	Labor	Total[1]
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Trench Silos						
Field forage harvester	4.59	2.33	7.04	1.37	0.70	2.12
Binder	4.66	3.60	8.37	1.52	1.19	2.73
Mower	4.99	1.89	7.07	2.02	.77	2.82
All methods[2]	4.59	2.55	7.28	1.50	.88	2.43
Upright Silos						
Field forage harvester	4.88	2.54	7.59	1.73	0.90	2.70
Binder	5.03	5.57	10.64	1.35	1.57	2.94
All methods[3]	4.61	3.16	7.93	1.98	1.40	3.44
ALL OPERATIONS	4.60	2.75	7.47	1.64	1.04	2.73

[1] Total costs include charges for extra packing and preservatives and, therefore, are more than the sum of machinery and labor costs.

[2] Two operations cut corn by hand and are included here. These two operations had an average machine cost of $2.76 per hour.

[3] Three operations used a mower to harvest silage and are included in these figures. They had an average machine cost of $2.30 per hour.

3. Machine costs made up 65 per cent of all costs for this group, but only 47 per cent of total costs for the binder-upright silo operations. The other extreme was the mower group, for which machine costs were 71 per cent of total costs.

These differences in costs are also expressed in terms of hours of labor, machine time, and related factors, by type of silo and method of harvest in Table 4. The average number of workers varied from 3.9 for the group using mowers to 11.1 for the group using binders. Performance rates, as measured by the time required to harvest an acre and the tons harvested per hour, varied among harvesting methods. However, yields also varied, so that these differences cannot be attributed entirely to the method of harvesting.

TABLE 4. AVERAGE ACREAGE, YIELD, AND PRODUCTION AND AVERAGE NUMBER OF MEN AND MACHINES USED TO HARVEST SILAGE BY DIFFERENT METHODS AND SOME ASSOCIATED FACTORS, 87 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Item	Unit	Trench silo			Upright silos		All silos
		Field forage harvester	Binder	Mower	Field forage harvester	Binder	
Silage operations	No.	40	11	8	18	5	87[1]
Average acreage harvested	Acres	28	20	17	30	25	26
Average quantity harvested	Tons	146	101	98	182	100	137
Average yield per acre	Tons	5.8	5.2	5.9	6.7	4.2	5.7
Average no. of men	No.	4.6	7.2	3.9	5.1	11.1	5.5
Average man hours per ton	Hours	1.4	2.4	1.5	1.8	3.2	2.1
Average tons per hour	Tons	4.0	3.7	3.0	4.0	4.1	3.7
Average operating hours per acre[2]	Hours	1.6	1.6	2.3	2.0	1.2	1.9
Machines used							
Field forage harvester	No.	1	0	0	1	0	
Blower	No.	0	0	0	1	0	
Binder	No.	0	1	0	0	1	
Cutter	No.	0	1	0	0	1	
Mower	No.	0	0	1	0	0	
Buckrake	No.	0	0	1	0	0	
Tractors	No.	2.7	4.3	2.9	2.2	3.4	2.8
Wagons	No.	1.5	1.6	.4	.3	2.2	1.1
Trucks	No.	.8	.5	.4	1.7	.2	.9

[1] Two operations using trench silos cut corn by hand and three using upright silos cut forage with a mower. These are included in totals for all silos.

[2] Average operating hours per acre for men and machines in carrying out silage operations.

Field Forage Harvesters, Upright Silos

Field forage harvesters were used for 18 operations.[2] For these operations, harvesting costs ranged from $0.62 to $5.53 per ton, with an average cost of $2.70 per ton of silage harvested. The machine combination generally used consisted of a field forage harvester, a blower, 2 large tractors, and 2 trucks, Appendix Table 7. The size of crew varied from 4 to 7 men. Eleven operations used 5 men, 3 operations used 4 men, 3 used 6 men, and 1 used 7 men. Most of the fields harvested were reported to be fairly level and were located within 1,000 yards of the silo. The acreage harvested, however, varied from 12 to 100 acres. About two-thirds of the farmers reported 15 to 30 acres harvested. The difference in acreage harvested should not affect physical performance rates, however, for the time required to cut an acre should be independent of whether the total operation is carried on for several days or for 1 or 2 days.[3]

Yields per acre varied from about 1 ton to more than 13 tons; however, a third of the yields were 4.5 to 5.5 tons per acre.

In general, the higher the tonnage harvested per hour, the fewer hours required per acre. In other words, there was a pronounced inverse relationship between hours required to harvest an acre and tons harvested per hour.[4] There were wide variations in hours per acre and tons harvested per hour for similar yields, Figure 1-A. This indicates that even though the same numbers and kinds of machines were used to harvest comparable yields, the efficiency with which they were used varied. This difference in efficiency affects per ton costs of harvesting silage, as shown in Figure 1-B. With similar yields, costs per ton increase as more time is spent cutting an acre or as fewer tons are harvested per hour. For example, costs for harvesting 9-ton yields varied from about $0.94 to $1.98 per ton. Some farmers were better able than others to organize their work force into an efficient unit. This points up the necessity for each operator to calculate the best combination of men and ma-

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[2] Thirteen farms, 5 of which made silage twice during the year.

[3] Performance rates will probably vary if the operation continues for only a few hours, because the time required to get the combination of men and machines going makes up a larger percentage of the total time used.

[4] The data have a gross correlation coefficient of — 0.55 (significant at 95 per cent probability level) which means that about 30 per cent of the variation in number of tons harvested per hour is accounted for by the time used to harvest an acre of forage.

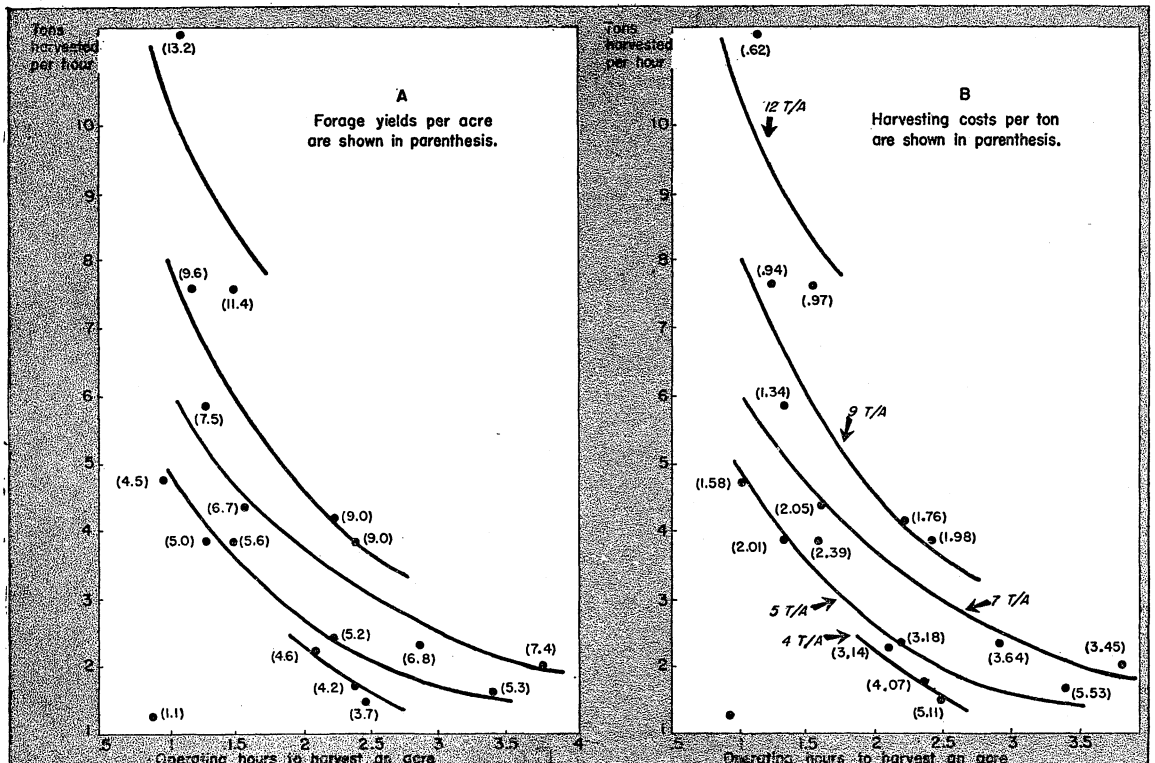

FIGURE 1. Relationship between tons of silage harvested per hour and time required to harvest an acre, 18 operations using field forage harvesters and storing in upright silos.

chines for his operation and not to copy entirely that of his neighbors. It also illustrates the need for observation and imagination on the part of the operator to vary the work plan to reduce the time required for some jobs and to combine procedures to eliminate other jobs. These data indicate that on many farms there is the possibility of lowering the cost of harvesting silage by reorganization of the operation.

Field Forage Harvesters, Trench Silos

Field forage harvesters were used for 40 operations having trench silos.[5] The average cost per ton of harvesting silage was $2.12, with a range from $0.80 to $4.48. Machine combinations were more variable for farmers using trench than upright silos, Appendix Table 8. For both types of silos there was a similar relationship between hours to harvest an acre and tons harvested per hour. Likewise, a similar conclusion can be drawn concerning the possibility for lowering costs through reorganization of the work process.

Bottlenecks and Harvesting Costs

A bottleneck existed when all machines were not fully employed, that is, when some machines were idle. Cost comparisons were made for operations with and without bottlenecks for those operators who used field forage harvesters and stored in trench silos. Two groups were set up according to the cause of the bottleneck—whether in cutting or in hauling or unloading. These were compared with operations that had no bottleneck, Table 5.

Very little difference was noted between operations with cutting bottlenecks and those with no bottlenecks. Yields were lower in operations where the harvester could not fill wagons fast enough than in either of the other groups. Therefore, in this group, fewer tons were harvested per hour and higher harvesting costs per ton resulted.

Fewer resources — men and machines — were used in those operations that reported hauling and unloading bottlenecks. In these operations the field forage harvester had to wait in the field

[5] Thirty-four farms were in this category, 6 of which made silage twice during the year.

TABLE 5. RELATIONSHIP BETWEEN KIND OF BOTTLENECK AND SOME EFFICIENCY FACTORS IN HARVESTING SILAGE WITH FIELD FORAGE HARVESTER AND STORING IN TRENCH SILOS, 39 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Item	Unit	Kind of bottleneck		
		Cutting	Hauling or unloading	None
Silage operations	No.	8	13	18
Average no. of men	No.	5.0	4.0	5.1
Average no. of tractors	No.	2.9	2.9	2.6
Large	No.	.8	.7	1.3
Medium	No.	1.0	1.5	.7
Small	No.	1.1	.7	.6
Average no. of wagons	No.	2.2	1.9	2.6
Average no. of trucks	No.	2.0	1.2	2.0
Average operating hours per acre[1]	Hr.	1.2	2.1	1.4
Average tons per hour	Tons	3.8	2.8	5.0
Average yield per acre	Tons	4.8	5.6	6.7
Average distance to silo	Yd.	1,274	1,052	1,535
Average proportion of time machines idle	Pct.	12	28	2
Average cost per ton	Dol.	2.02	2.60	1.83

[1] Average operating hours per acre that all men and machines were used in carrying out silage operations.

for empty wagons. This resulted in longer harvesting time per acre and fewer tons harvested per hour. Costs per ton were also higher for this group than for either of the other two groups.

Comparison of Cost of Harvesting Corn and Grass Silage

Up to this point, the effect of the kind of forage on costs has not been considered. However, because of the difference in physical characteristics of corn and grass, operation costs were compared according to yield rather than the kind of forage harvested. If normal weather prevailed, a classification of farms on a yield-per-acre basis would be largely a classification on kind of forage because corn usually yields 10 to 20 tons per acre as compared with 5 to 10 tons from small grain or grass silage. However, yields of corn were considerably reduced by a severe drought in 1954.

A comparison was made of the cost of harvesting corn and grass silage by pairing operations having similar yields. Six pairs of operations that had yields ranging from 2.4 to 5.2 tons per acre were studied. Performance rates, as measured by the time used to har-

vest an acre and tons harvested per hour, were about the same for corn and grass, even though fewer men and machines were used in the grass operations.

A Framework for Planning

The cost of making a ton of silage depends on the tonnage harvested per hour and the cost per hour for men and machines used. When making silage farmers attempt to keep operating costs low and tonnage produced high. However, these two objectives often conflict. Some basis for making a decision is needed.

A general rule to guide farmers in making silage for the least cost for given conditions on any farm can be stated. However, it should first be pointed out that keen observation on the part of the operator is an important factor in making low-cost silage. If certain tasks can be eliminated or the time reduced for some operations without adding more men or machines, the cost per ton will decrease. The rule is to add men or machines, or both, as long as the percentage change in hourly costs is less than the percentage change in tons harvested per hour. The reverse is also true. Costs will decrease if by using fewer men or machines, the percentage reduction in costs is greater than the percentage reduction in tons harvested per hour.

Farmers try to have each job in the silage harvesting operation performed most efficiently. This means that thought should be given to the order and the manner in which work is done. Often through simple reorganization of work procedures, the same job can be done either by fewer men and machines or by the same work force in less time. If this can be accomplished, costs per ton will decrease.

Forage yields per acre greatly affect the amount of silage harvested in an hour. In comparing man-machine operations, comparisons should be made only for similar yields.

To illustrate the rule, consider "Farmer Greenacres." He uses a field forage harvester pulled by a large tractor to cut the forage. Two wagons are used to haul silage from the field to a trench silo. While being filled, the wagons are pulled behind the harvester. A small tractor is used to shuttle wagons from field to silo. A medium sized tractor is at the trench to unload and pack. Unloading is a simple process, for the bottom of each wagon is covered with woven

wire. The medium tractor hooks onto the wire and dumps the load of silage into the trench. In addition to the three tractor drivers, one other man is at the trench to help level the silage while it is being packed. Costs for these operations are $5.91 per hour, Table 6.

TABLE 6. FARMER GREENACRES' HOURLY OPERATING COSTS FOR MAKING SILAGE, BY OPERATION AND BY MACHINE

Operation	Machine and operator	Cost per hour		
		Fixed	Fuel	Total
		Dol.	*Dol.*	*Dol.*
Cutting	1 field forage harvester	1.40		
	1 large tractor	.54	0.54	
	1 man	.50		2.98
Haul and unload	2 wagons	.08		
	1 small tractor	.39	.25	
	1 man	.50		1.22
Pack and unload	1 medium tractor	.45	.26	
	2 men	1.00		1.71
TOTAL COSTS PER HOUR		4.86	1.05	5.91

Farmer Greenacres harvests 4 tons of silage per hour with this combination of men and machines. However, he observes that the field forage harvester has to wait occasionally for the returning wagons. Knowing that the cost of this waiting is $2.98 per hour, he wonders what would happen to the cost per ton of harvesting silage if an additional small tractor and wagon were added and the extra man at the trench was used as the driver.

If average costs listed in Table 1 are used, hourly operating costs increase 11.5 per cent from $5.91 to $6.59, or $0.68 per hour. In order for costs per ton to decrease, the tonnage harvested per hour must increase more than 11.5 per cent, or from 4 to at least 4.5 tons per hour. If adding another tractor and wagon does not speed up the operation this much, then costs per ton are less with the original organization.

If the tractor and wagon to be added would be idle unless used in the silage operation, fixed costs should not be included when costs are calculated. Rather, only the actual variable costs incurred should be included.

Variable costs will probably differ from farm to farm. For illustration purposes, 25 per cent of the fixed costs in Table 1 are

charged as variable costs to take care of wear and tear. This amounts to $0.10 per hour for a small tractor plus $0.25 for fuel and $0.01 per hour for a wagon, or an increase of $0.36 per hour. Using this concept of costs rather than total costs, only 4.25 tons per hour need to be harvested for silage costs per ton to decrease, as adding $0.36 to costs increases hourly operating costs from $5.91 to $6.27, or 6 per cent.

Farmer Greenacres should use only variable costs in deciding whether to add the tractor and wagon if these machines are standing idle. If, however, he must hire them at average rates, then he must use the actual rental rates paid.

If with the use of an extra tractor and wagon, 4.33 tons of silage are harvested per hour, they should be added if available and not in use. However, if both fixed and variable costs must be paid for by the silage operation, Farmer Greenacres could afford to take a little longer to make silage and not use the additional tractor and wagon.

STORAGE PRACTICES and COSTS

Costs of constructing and maintaining a trench silo are generally much less than for an upright silo of comparable capacity. Total annual costs, including repairs, depreciation, interest on investment, and sealing silage, averaged about 27 cents per ton of silage for trench silos and about 78 cents per ton of silage for upright silos, Table 7.

TABLE 7. COMPARISON OF TRENCH AND UPRIGHT SILOS, 70 FARMS,[1] 4-COUNTY AREA, ALABAMA, 1954-55

Item	Unit	Trench silos	Upright silos
Farms having silos	Number	51	19
Number of silos	Number	62	24
Farms having more than one silo	Number	10	5
Average acreage harvested for silage	Acres	30	36
Average tonnage harvested	Tons	156	200
Average silo size	Tons	200	178
Average storage capacity per farm	Tons	244	225
Proportion of capacity utilized	Per cent	68	85
Average cost of constructing silos	Dollars	84.00[2]	1,541.00
Average construction cost per ton of capacity	Dollars	.51	8.69
Average farm investment in silos	Dollars	97.00	1,916.00
Average annual silo charge	Dollars	13.79[3]	116.00[3]
Average annual costs per ton capacity	Dollars	.09	.69
Average annual costs per ton harvested	Dollars	.14	.78
Average annual sealing costs per ton harvested	Dollars	.13[4]	.00
Average annual total storage costs per ton harvested	Dollars	.27	.78
Proportion of silage spoiled	Per cent	5.7	2.5[5]
Average no. of men used in harvesting process	Number	5.1	6.8
Proportion of harvesting operation using			
Field forage harvester	Per cent	66	68
Binder	Per cent	18	20
Mower	Per cent	13	12
Cut by hand	Per cent	3	----
Kind of bottleneck			
None	Per cent	32	0
Cutting process	Per cent	19	21
Hauling and/or unloading	Per cent	49	54
Blower or cutter	Per cent	----	25
Proportion of time machines idle	Per cent	21	25

[1] One farmer used both a trench and upright silo and is not included.

[2] One silo costing $3,000, and 2 costing $1,250 each are excluded from this average.

[3] Includes repairs, depreciation, and interest.

[4] Eleven farmers did not seal silos. If these farms are excluded, average sealing costs for farms on which this operation was performed become $0.17.

[5] Five farmers fed silage as soon as it was put in the silo. Therefore, they had no spoilage and are excluded from the average.

Trench Silos

Trench silos varied in capacity from 50 tons to more than 500 tons and in construction costs from $4 to more than $1,200. The silo built for $4 was a field gully that was shaped to make the sides and bottom smooth. The $1,250 trench silos had the sides, floor, and one end surfaced with concrete. Some relationship between size and total cost was evident. This association is suggested by the following data:

Construction cost per silo	*Average size in tons*	*Construction cost per ton of capacity*
Under $50	125	$0.37
$50—$100	195	.57
Over $100	319	.62

If the three highest cost silos are included, construction costs per ton of capacity for silos costing more than $100 become $1.35 per ton. The usual tendency for unit costs to decline as units become larger was not true for the trench silos studied. The smaller silos may have been located in sites already partially depressed, such as natural ravines or eroded gullies, whereas the larger trenches were on sites that needed to be more fully excavated.

Annual costs include charges for depreciation, interest, and repairs. Repair costs, cleaning out the silo and reshaping the sides and bottom, averaged $6.33 per silo for the farms that reported repairs. Assuming that farmers repair trench silos in 2 years out of 5, as indicated by the fact that 42 per cent of the farmers repaired silos during the year covered by the study, the average annual cost of repairs is about $2.64 per year. Charges for depreciation and interest on investment averaged about $11.15 per silo. For trenches located in pasture fields, there may be an additional cost for fencing to keep cattle away from the silo.

These annual costs can be considered as fixed costs and are not affected by the quantity of forage stored in the silo. The same costs are charged against the silo whether the capacity is partially or fully utilized. Therefore, the costs per ton of storing silage decrease as more silage is put in the silo. For example, if silos had been filled to capacity the average per ton storage costs would have been $0.09.[6] On the average, silos were only 68 per cent filled, spreading annual costs over only 156 tons, which resulted in a per ton storage cost of $0.14[6].

[6] These costs are a simple average of per ton storage costs on individual farms.

To preserve silage, trench silos are usually covered or sealed. Eighty-four per cent of the farmers having trench silos used some kind of cover on their silos at a cost of $16.44 per silo, or $0.13 per ton of silage. Thirty-seven per cent of the farmers who sealed their silos used sawdust, 19 per cent used a combination of hay and sawdust, 19 per cent used tarpaper and sawdust, while 14 per cent used only dirt to cover the silage. Other materials used included crushed limestone, grass, pine straw and dirt, and a plastic cover.

Preservation of the silage was the main purpose of sealing trench silos, but as only a few trench silos were not covered, a comparison of the difference in the amount of spoiled silage between sealed and unsealed silos was not feasible. However, some comments on spoilage follow.

Farmers reported 5.2 per cent of the corn and sorghum silage spoiled and 6.4 per cent of the oats and clover silage spoiled. In an effort to reduce spoilage and improve the quality of silage, 18 per cent of the farms having trench silos used water when the forage was put into the silo. Corn and sorghum were the only crops on which water was used, and 26 per cent of the farmers who made corn or sorghum silage in 1954 used water. These percentages may be higher than usual, since much of the corn harvested for silage in 1954 was affected by the drought.

For farms using water, spoilage was 3.9 per cent as compared with 5.5 per cent for farms not using water. However, the number of cases was too small to draw definite conclusions. Sodium metabisulphite was used on two farms in making grass-legume silage.

Upright Silos

Upright silos had an average capacity of 178 tons and varied in size from 62 to 254 tons. The average cost of constructing an upright silo was $1,541, or $8.69 per ton of capacity. Fifty-eight per cent of the upright silos were built after 1950, 21 per cent were built during the 1940's, and 21 per cent sometime before 1940.

Thirty-two per cent of the farmers repaired their silos at an annual cost of $12.97 per silo serviced, or $4.04 for all upright silos. In all instances, the repairs consisted of painting the silo, which the farmers indicated they planned to do every 3 years.

Annual charges for depreciation and interest averaged about $112 per upright silo. Thus, total annual costs, including repairs, were

TABLE 8. TWO COMPARISONS ILLUSTRATING THE RELATIONSHIP BETWEEN TONNAGE STORED AND PER TON STORAGE COSTS

Item	Unit	Costs reported on different farms			
		Comparison I		Comparison II	
		Farm 50	Farm 49	Farm 56	Farm 67
Capacity	Tons	221	225	169	198
Annual cost	Dollars	131	141	128	151
Cost per ton capacity	Dollars	.59	.63	.76	.76
Quantity stored	Tons	191	334[1]	120	262[1]
Proportion of capacity utilized	Per cent	86	148[2]	71	130[2]
Cost per ton stored	Dollars	.69	.42	1.07	.58

[1] Silage was made in the spring and in the fall.
[2] Silo was refilled after silage was fed, which accounts for the figure being more than 100 per cent.

$116 per silo for an average capacity of about 179 tons, or about 69 cents[7] per ton of capacity. Only 85 per cent of the available capacity was utilized, so that annual costs per ton of silage stored were 78 cents.[7] This amount is the annual charge regardless of how many tons of silage are stored. Total storage costs are not affected much by the tonnage stored but costs per ton are directly related to the number of tons stored. This is illustrated by examples in Table 8.

In the examples shown in Table 8, the storage cost per ton of capacity on Farm 49 was about the same as on Farm 50, and that on Farm 67 was comparable with that on Farm 56. However, as the silos were utilized more fully on Farms 49 and 67, these operators had lower storage costs per ton of silage stored. This does not mean that total storage costs were less on Farms 49 and 67, but rather that about twice as much silage was stored for the same cost. A difference in total farm costs may show up, however, if the operators of Farms 50 and 56 must provide storage space for other roughage, such as hay, to meet feed requirements.

Only about a third of the upright silos had roofs. No difference in the spoilage rate between silos having roofs and those without roofs was reported by farmers. Operators of five farms, or about 25 per cent, used preservatives. Two used sodium metabisulphite for grass-legume silage, two used water in packing corn silage, and one used molasses and water for oat silage. Some farmers began to feed silage as soon as it was harvested, thereby eliminating top spoilage — the most frequent place spoilage occurred in up-

[7] These costs are a simple average of per ton storage costs on individual farms.

right silos. Spoilage amounted to 2.5 per cent for those silos from which silage was not fed immediately.

FEEDING PRACTICES and COSTS

On the average, the cost of feeding silage represented 23 per cent of the total cost of harvesting, storing, and feeding silage. Feeding costs varied from an average of $1.23 per ton for silage fed from trench silos to an average of $0.96 per ton for upright silos. Variations in feeding costs from farm to farm were quite great for trench silos. Silage was fed on 10 per cent of the farms using trench silos at a cost of less than $0.50 per ton, while the high 10 per cent had costs of more than $2.00 per ton. There was less variation in feeding costs from upright silos. Almost 30 per cent of the farmers with upright silos fed silage at less than $0.50 per ton and the highest cost group, which made up less than 25 per cent of the farmers having upright silos, had costs from $1.50 to $1.65 per ton.

The time spent in feeding a ton of silage varied from a half hour to more than 4 hours. The average feeding time per ton for all farms was 1.7 hours. The major factor that appeared to be associated with high labor cost per ton was the amount of silage fed per feeding. Most of the operations having high labor requirements per ton fed less than 1,000 pounds of silage per feeding. In general, farms on which small quantities of silage were fed had the highest feeding costs and vice versa.

Most of the farmers fed silage only once a day, and morning was the more preferred time. On dairy farms, silage was fed at milking time in 83 per cent of the instances where upright silos were used, but only 10 per cent of the farmers using trench silos fed silage at milking time. Where trench silos were used, half of the farmers fed silage in a pasture field and the other half fed it at the barn lot. In many instances where silage was fed in pastures, trenches were located in the same field.

Tractors and wagons were used to haul silage to the place of feeding on 70 per cent of the farms having trench silos, trucks were used on 18 per cent, tractors and scoops on 7 per cent, and feedcarts on 5 per cent. As silage from upright silos was fed at or near the silo, only 24 per cent of the farmers used tractors and wagons, while 40 per cent used feedcarts, 12 per cent carried the silage in baskets, 12 per cent used forks, 6 per cent used wheelbarrows, and 6 per cent used trucks.

Farmers reported that silage was fed as a partial substitute for other feeds, mainly hay. However, in some instances silage completely replaced other feeds in the ration. Sixty-five per cent indicated that milk production increased when silage was fed, with the reported increase ranging from "only a little" to "very much." In many instances the increase was attributed to greater total intake of feed, while some attributed it to silage being a milk stimulus as compared with a nonsilage ration.

Seventy per cent of the farmers indicated that some hay and grain were fed along with silage. In addition, a third of the herds that received hay and grain had grazing other than permanent pasture at some time during the silage-feeding period. Almost a fourth of the herds received no hay when silage was fed; their ration consisted of concentrates and silage. However, half of this group also had grazing other than permanent pasture at some time during the silage feeding period. Only 6 per cent of the herds received no concentrates when fed silage. Half of this group received hay while the other half had only silage and access to permanent pasture.

The number of days silage was fed varied. A fourth of the farmers fed less than 100 days and a fourth fed more than 200 days. The feeding period was longer for farms having upright silos.

SUMMARY

Silage is becoming more important as a source of feed on Alabama livestock farms. Corn is still the most prevalent silage crop, but grass-legume silage is an important second.

For farms in the study, the average cost of harvesting, storing, and feeding a ton of silage was $3.93 for trench silos and $5.18 for upright silos. The average cost per ton of harvesting and putting silage in trenches varied from $2.12 when field forage harvesters were used to $2.82 when mowers were used. With binders, the cost was $2.73 per ton.

Harvesting and storing silage in upright silos was slightly more expensive than in trench silos. Costs for upright silos averaged $2.70 for field forage harvesters and $2.94 for binders.

On the average when field forage harvesters were used, fewer men and machines were used in harvesting than with other methods. An average of 4.6 men were used when silage was cut by field forage harvesters and placed in trenches, compared with an average of 5.1

men when silage was stored in upright silos. When binders were used, the crew averaged 7 and 11 men for silage stored in trench and upright silos, respectively.

Making silage is an expensive operation. Labor and machine costs averaged more than $7 per hour. However, machines were idle an average of 20 per cent of the time in the operations studied. Organization of men and machines in an operating unit determines to a large extent whether harvesting costs are high or low. For many farms, silage harvesting costs can be reduced by more efficient organization and use of men and machines.

Harvesting costs made up more than 60 per cent of the total costs of harvesting, storing, and feeding silage for both trench and upright silos. Storage costs were 7 per cent of all costs for trenches, but 15 per cent for upright silos. Feeding costs, however, were 31 per cent for trench silos and only 19 per cent for upright silos.

Initial construction costs for upright silos were much greater than for trench silos, but direct annual costs were greater for trenches. When both types of costs were combined, total storage costs per ton were $0.27 for trench silos and $0.78 for uprights. Spoilage, however, was 5.7 per cent for trenches and 2.5 per cent for upright silos.

Feeding from upright silos cost less than from trench silos — $0.96 and $1.23 per ton, respectively. Silage was usually fed once a day, in the morning. On farms with upright silos, silage was usually fed at milking time. Ordinarily, upright silos were located near the barn, but trench silos were commonly located in pastures.

Silage was reported fed mainly as a substitute for hay. Farmers stated that milk production increased when silage was fed and attributed the increase to greater feed intake. However, some farmers expressed the opinion that silage stimulated milk production.

APPENDIX

Method of Determining Silo Capacity and Tonnage Harvested

Silo capacity and tonnage harvested were calculated by determining cubic volume from dimensions reported by farmers and multiplying by the appropriate density per cubic foot. The densities used in this study were chosen because they were comparable to the results from several controlled silage experiments carried on at the Alabama Station.[1] The densities used or sources from which they can be obtained are presented below:

Trench silo	Upright silo	
	Settled Silage	Not settled[2]
Corn silage 40 lb. per cu. ft.	Densities reported in Table 4, U.S.D.A. Farmers Bulletin 1820	Tonnage reported in Table 3, U.S.D.A. Farmers Bulletin 1820
All silage other than corn, 45 lb. per cu. ft.	Corn figure times 1.25	Corn figure times 1.25

Although the densities used for upright silos increased with the depth of forage in the silo, a constant density was used for trench silos regardless of silage depth. However, most of the silage in trench silos was stored at depths of 5 to 8 feet. Therefore, densities probably did not vary significantly.

[1] These experiments were not designed to measure density, but a rough estimate was calculated from the known tonnage and the cubic area filled.

[2] Silage not settled are those instances in which farmers started feeding immediately or where the record was taken soon after silo filling time and the farmer did not know how much the silage had settled or was likely to settle.

APPENDIX TABLE 1. LAND USE, CROPLAND, AND LIVESTOCK ORGANIZATION, 71 FARMS HARVESTING SILAGE, 4-COUNTY AREA, ALABAMA, 1954-55

Item	Trench						Upright						All silos		
	Harvester			All methods			Harvester			All methods			All methods		
	Pro. of farms re-port-ing[1]	Average		Pro. of farms re-port-ing[1]	Average		Pro. of farms re-port-ing[1]	Average		Pro. of farms re-port-ing[1]	Average		Pro. of farms re-port-ing[1]	Average	
		Farms re-port-ing	All farms		Farms re-port-ing	All farms		Farms re-port-ing	All farms		Farms re-port-ing	All farms		Farms re-port-ing	All farms
Land use	*Pct.*	*Acres*	*Acres*	*Pct.*	*Acres*	*Acres*	*Pct.*	*Acres*	*Acres*	*Pct.*	*Acres*	*Acres*	*Pct.*	*Acres*	*Acres*
Acres in farm	100	327	327	100	292	292	100	688	688	100	652	652	100	394	394
Cropland acres	100	206	206	100	182	182	100	345	345	100	313	313	100	218	218
Cotton	26	21	5	24	20	5	0	0	0	1	30	1.5	18	21	4
Corn, grain	71	22	15	69	27	19	0	0	0	25	34	8	56	28	16
Permanent pasture	97	92	89	94	76	72	100	200	200	100	188	188	96	109	104
Alfalfa	29	7	2	24	8	2	0	0	0	5	20	1	18	9	2
Silage crops	100	29	29	100	30	30	100	41	41	100	36	36	100	31	31
Corn	65	23	15	65	23	15	8	30	2	35	28	10	56	24	14
Sorghum	16	21	3	14	18	2	31	20	6	20	20	4	15	19	3
Crimson clover-grass	26	34	9	35	30	11	62	39	24	40	39	16	37	33	12
Sudan grass	6	14	1	4	14	.6	31	18	6	25	17	4	10	16	2
Other	10	12	1	6	12	.7	8	40	3	10	21	2	7	16	1
Livestock	*Pct.*	*No.*	*No.*	*Pct.*	*No.*	*No.*	*Pct.*	*No.*	*No.*	*Pct.*	*No.*	*No.*	*Pct.*	*No.*	*No.*
Dairy cows	87	36	32	92	33	31	100	101	101	100	76	76	94	46	44
Heifers	84	21	18	90	21	19	100	69	69	100	49	49	93	29	27
Herd sires	65	1.6	1.1	71	1.6	1.1	100	3.5	3.5	95	2.7	2.6	77	2	1.5
All beef animals, (animal units)	48	44	22	37	36	13	25	7	2	26	43	11	34	37	12
Horses and mules	52	1.6	.8	53	1.6	.8	54	3.6	1.9	55	2.8	1.6	54	1.9	1.0

[1] Trenches were on 51 farms, 31 of which used field forage harvesters. Upright silos were on 19 farms, 12 of which used field forage harvesters. One farm had both a trench and upright silo and used a field forage harvester.

APPENDIX TABLE 2. NUMBER AND PROPORTION OF FARMERS MAKING VARIOUS KINDS OF SILAGE, 71 FARMS, 4-COUNTY AREA, ALABAMA, 1954-55

Kind of silage	Trench		Upright		All silos	
	No.	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*
Corn and/or sorghum	30	59	9[1]	47	39	55
Spring grass-legume	14	27	4	21	18	25
Summer grass	2	4	1	5	4[2]	6
Grain—spring grass-legume	5	10	2	11	7	10
Spring grass—summer grass	0	0	3	16	3	4

[1] One farmer made both corn and soybean silage.
[2] One farmer who made sudan silage used both trench and upright silos.

APPENDIX TABLE 3. NUMBER OF FARMERS WITH VARIOUS YEARS EXPERIENCE USING TRENCH OR UPRIGHT SILOS, 68 FARMS, 4-COUNTY AREA, ALABAMA, 1954-55

Years of experience	Trench silos	Upright silos	All silos
	No.	*No.*	*No.*
0	10	2	12
1	11	3	14
2	6	4	10
3	13	1	14
4	4	2	6
5	2	1	3
Over 5	3	6	9
TOTAL	49	19	68

APPENDIX TABLE 4. PROPORTION OF FARMERS USING FIELD FORAGE HARVESTERS, BINDERS, AND MOWERS TO HARVEST SILAGE BY YEARS OF EXPERIENCE, 68 FARMS, 4-COUNTY AREA, ALABAMA, 1954-55

Kind of machine	Years experience							All farms
	0	1	2	3	4	5	Over 5	
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Field forage harvester	92	79	50	50	83	0	45	63
Binder	8	7	0	36	17	100	22	18
Mower	0	7	40	7	0	0	11	12
Other	0	7[1]	10[2]	7[3]	0	0	22[4]	7
NO. OF FARMS	12	14	10	14	6	3	9	68

[1] Harvester and by hand.
[2] By hand.
[3] Harvester and binder.
[4] Harvester and mower, and binder and mower.

APPENDIX TABLE 5. PROPORTION OF FARMERS WHO OWNED, HIRED, OR TRADED FOR MACHINES TO HARVEST SILAGE, 71 FARMS, 4-COUNTY AREA, ALABAMA, 1954-55

Kind of silo	Field forage harvester			Binder			Mower		
	Own	Hire	Trade	Own	Hire	Trade	Own	Hire	Trade
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Trench	47	47	6	70	0	30	76	12	12
Upright	75	0	25	40	20	40	67	0	33
ALL SILOS	54	35	11	60	7	33	73	9	18

APPENDIX TABLE 6. PROPORTION OF DIFFERENT KINDS OF SILAGE HARVESTED BY VARIOUS METHODS, 87 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Kind of forage	Trench silo				Upright silos		
	Field forage harvester	Binder	Mower	By hand	Field forage harvester	Binder	Mower
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Corn	68	26	0	6	14	72	14
Crimson clover-grass	56	0	44	0	100	0	0
Sorghum	67	33	0	0	100	0	0
Sudan	100	0	0	0	75	0	25
Other	100	0	0	0	0	0	100
ALL KINDS	66	18	13	3	68	20	12

APPENDIX TABLE 7. NUMBER OF MACHINES AND MEN USED TO HARVEST SILAGE ON FARMS USING UPRIGHT SILOS AND FIELD FORAGE HARVESTERS, 18 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Number of operations	Number of machines					Number of men
	Field forage harvester	Blower	Tractors	Trucks	Wagons	
	No.	*No.*	*No.*	*No.*	*No.*	*No.*
1	1	1	2	1	0	4
2	1	1	2	2	0	4
8	1	1	2	2	0	5
3	1	1	2	2	0	6
1	1	1	2	2	0	7
1	1	1	3	1	1	5
2	1	1	3	0	2	5
AVERAGE	1	1	2.2	1.7	.3	5.1

APPENDIX TABLE 8. NUMBER OF MACHINES AND MEN USED TO HARVEST SILAGE ON FARMS USING TRENCH SILOS AND FIELD FORAGE HARVESTER, 40 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Number of operations	Number of machines				Number of men	
	Field forage harvester	Tractors	Wagons	Trucks	Range	Average
	No.	*No.*	*No.*	*No.*	*No.*	*No.*
1	1	2	2	0	-------	3
1	1	3	1	0	-------	3
8	1	3	2	0	3-5	4
1	1	3	3	0	-------	6
2	1	4	2	0	-------	4
6	1	4	3	0	5-7	6
1	1	4	4	0	-------	6
2	1	1	0	2	-------	4
1	1	2	0	1	-------	2.7
6	1	2	0	2	3.5-6	4.8
1	1	2	0	3	-------	5.5
2	1	3	1	1	2.7-6	4.4
1	1	3	1	2	-------	6.6
1	1	3	2	1	-------	3
1	1	4	2	1	-------	7
3	1	1[1]	0	2	-------	5
1	1	2	2	2[2]	-------	4.5
1	1	2[3]	2	0	-------	3
AVERAGE	1	2.7	1.5	.8	2.7-7	4.6

[1] A bulldozer was also used.
[2] A jeep was also used.
[3] A team of horses was also used.

APPENDIX TABLE 9. NUMBER OF MACHINES AND MEN USED TO HARVEST SILAGE ON FARMS USING BINDERS, 16 OPERATIONS, 4-COUNTY AREA, ALABAMA, 1954-55

Number of operations	Number of machines					Number of men
	Binders	Cutters	Tractors	Wagons	Trucks	
	No.	*No.*	*No.*	*No.*	*No.*	*No.*
Upright silos						
1	1	1	2	3	0	14
1	1	1	3	2	1	14.5
3	1	1	4	2	0	9
AVERAGE	1	1	3.4	2.2	.2	11.1
Trench silos						
1	1	1	3	1	0	4.8
2	1	1	4	2	0	6
1	1	1	4	2	0	8
1	1	1	4	2	0	9
1	1	1	5	3	0	9
1	1	1	5[1]	1	1	8
1	1	1	6[1]	1	1	8.3
1	1	1	6[1]	2	1	10
1	1	1	3	0	1	6
1	1	1	3	1	1	4
AVERAGE	1	1	4.3	1.5	.5	7.2

[1] A buckrake was also used.

APPENDIX TABLE 10. METHOD OF COMPUTING PER HOUR COSTS FOR MACHINES USED TO MAKE SILAGE, 4-COUNTY AREA, ALABAMA, 1954-55.[1]

Item	Field forage harvester	Binder	Mower	Tractor			Cutter	Blower	Wagon	Trailer	Buck-rake	Side delivery rake	Truck
				Large	Medium	Small							
Purchase price, dol.	1,500	284	237	2,700	2,100	1,740	260	500	150	105	660	390	----
Estimated life, yr.	9.2	20	10.5	10	10	10	15	15	17	17	15	15	----
Annual depreciation, dol.	146.74	12.78	20.31	243.00	189.00	156.60	15.60	30.00	7.94	5.56	39.60	23.40	----
Interest, dol.	41.25	7.81	6.52	74.25	57.75	47.85	7.15	13.75	4.12	2.89	18.15	10.72	----
Repairs cost, dol.	13.40[2]	14.44	30.06	63.30	63.30	63.30	16.46	[3]	1.14	1.45	13.30	8.00	----
Tire cost, dol.	----	----	----	55.92	47.75	33.04	----	----	----	----	----	----	----
Oil and grease, dol.	----	----	----	34.56	34.56	34.56	----	----	----	----	----	----	----
Total fixed costs, dol.	201.39	35.03	56.89	471.03	392.36	335.35	39.21	43.75	13.20	9.90	71.05	42.12	----
Annual use, hr.	144	92	134	868	868	868	89	123	329	303	62	86	----
Fixed cost per hour, dol.	1.40	.38	.42	.54	.45	.39	.44	.35	.04	.03	1.14	.49	.50

[1] Several cost items are omitted because of inadequate data to determine costs. These items are taxes, housing, and daily service charges to grease and adjust machines, sharpen knives, and check over equipment.

[2] Field forage harvesters varied in age from 1 to 3 years so that repair costs represent average repair charges for only the first 3 years of operation.

[3] No data on repairs for blowers were available.