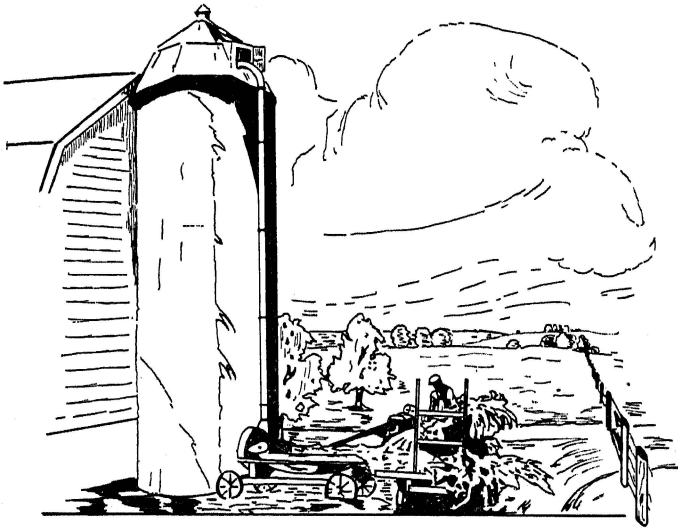UNIVERSITY OF MISSOURI    COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
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# Silo Filling Methods
# and Costs

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# Silo Filling Methods and Costs

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Silage is essential in economical dairy feeding and is valuable as a feed for other livestock. Many silos in Missouri, however, have been allowed to stand empty in recent years because of the expense, labor, and inconvenience of filling them. The Department of Agricultural Engineering of the Missouri Agricultural Experiment Station, therefore, in 1928 began studies of silo-filling methods in common use in Missouri with a view to determining how the expense, labor, and trouble of filling silos might be reduced. The results of these studies are reported in this bulletin.

SILAGE COSTS
(AVERAGE OF 152 Mo. FARMS)

| ITEM | COST | % |
|------|------|------|
| CORN | $4.65 | 70.0 |
| LABOR | .84 | 12.1 |
| POWER | .50 | 7.6 |
| SILO | .38 | 5.8 |
| MACH. | .24 | 3.6 |
| MISC. | .04 | 0.3 |
| TOTAL | $6.65 | 100% |
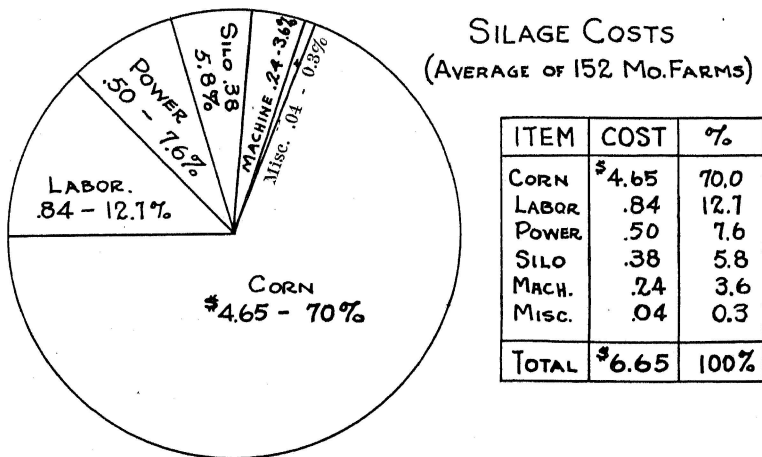
Fig. 1.—The corn used to make silage is the largest single item of silage cost.

## ITEMS OF SILAGE COST

The cost of silage may be divided into the following items: (1) silo costs; (2) corn and fodder costs; (3) labor costs; (4) power costs; and (5) machinery costs. The average of various items of silage cost on 152 Missouri farms in 1929, is shown in Figure 1. The largest single item is the cost of the corn used in making the silage. Figure 2 shows the relative proportions of the various items of silage cost, when the cost of the corn is excluded. Labor is then the largest single item, being 42 per cent of the total. Power costs represent 25 per cent of the total; machinery

## Silage Costs
### Exclusive of Corn Value
### Average of 152 Mo. Farms.

Silo - .38 19%

Machine .24 - 12%

Power .50 - 25%

Labor .84 - 42%

| ITEM | COST | % |
|------|------|-----|
| Labor | $0.84 | 42 |
| Power | 0.50 | 25 |
| Silo | 0.38 | 19 |
| Machine | 0.24 | 12 |
| Misc. | 0.04 | 2 |
| Total | $2.00 | 100% |
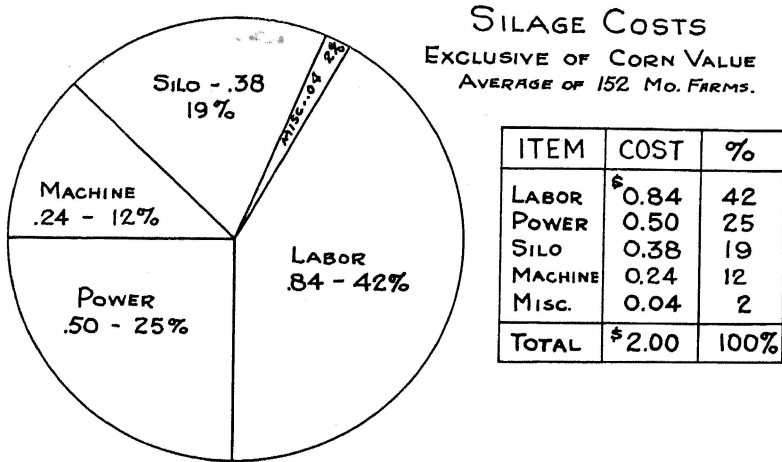
Fig. 2.—Power and labor expense represent about two thirds of the cost of silage, exclusive of the corn used.

costs, 12 per cent; silo costs, 19 per cent; and miscellaneous costs, including twine, 2 per cent. It is evident, therefore, that any attempt to lower the cost of making silage should be directed towards the lowering of labor costs and power costs, as these items are the largest ones.

## METHOD OF MAKING THE STUDIES

Shortly after the silo-filling season of 1929, record blanks were placed in the hands of 680 Missouri farmers who had filled silos, with requests for such information on their costs and methods of filling as they could give. Usable records were obtained from 326 of these, 152 of them being complete, and 174 others giving some useful information about one or more of the above mentioned items of their silo-filling expense. Part of the records were obtained by personal interview with the farmers, but most of them were obtained by mail. These records were analyzed and cost figures determined as explained in the following pages.

Although collecting data by the survey method may not give absolutely accurate results for all individual cases, it doubtless will give reasonably reliable average results.

## INDIVIDUAL COSTS VARY

One of the most significant facts found from a study of these records is that there is great variation in silage costs on the different farms. (See Table 1.)

TABLE 1.—VARIATIONS IN ITEMS OF SILAGE COST PER TON

| Item | No. of farms | Average of highest 25 % | Average of lowest 25 % | Average of all |
|---|---|---|---|---|
| Total silage cost, including corn | 152 | $8.91 | $4.67 | $6.65 |
| Total silage cost, except corn cost | 152 | 2.62 | 1.42 | 2.00 |
| Silo cost | 267 | .63 | .19 | .38 |
| Binder cost | 115 | .30 | .07 | .16 |
| Ensilage cutter cost | 250 | .35 | .07 | .18 |
| Total machinery cost | 231 | .44 | .10 | .24 |
| Total power cost | 235 | .73 | .33 | .51 |
| Total labor cost | 255 | 1.10 | .49 | .83 |
| Horse labor cost on binder | 113 | .14 | .05 | .09 |
| Horse labor cost, hauling | 289 | .36 | .15 | .24 |
| Engine cost for operating ensilage cutter | 260 | .35 | .11 | .21 |
| Man hours per ton, field cutting by hand | 107 | 1.71 | .54 | 1.03 |
| Man hours per ton, field cutting with sled | 17 | 1.13 | .36 | .65 |
| Man hours per ton, field cutting with binder | 106 | .50 | .19 | .32 |
| Man hours per ton tramping | 265 | .70 | .17 | .40 |
| Man hours per ton, loading, hauling, and feeding cutter, bound | 122 | 2.32 | .92 | 1.54 |
| Man hours per ton, loading, hauling and feeding cutter, unbound | 128 | 2.67 | 1.17 | 1.82 |
| Man hours per ton running engine | 204 | .36 | .12 | .22 |
| Total labor, man hours per ton | 256 | 4.29 | 1.72 | 2.91 |

While the average cost of silage, exclusive of the corn, on 152 farms was $2.00 per ton, the average of the highest 25 per cent was $2.62 per ton, and the average of the lowest 25 per cent was $1.42 per ton. The total cost of silage including the value of the corn, averaged $6.65 per ton, with the highest 25 per cent averaging $8.91, and the lowest 25 per cent averaging $4.67. Although it is true that a large part of the differences in total cost, including the value of the corn, is due to differences in the amount of grain on the stalks, still an appreciable part of these differences in costs can be traced to differences in efficiency in the use of labor and power. The fact that many farmers are able to produce silage at low costs, indicates that others might also be able to produce silage at low costs.

## CUTTING CORN IN THE FIELD

Practically all of the silos included in these studies were filled by cutting the corn in the field by the hand, binder, or sled method, then hauling it to the silo and running it through the ensilage cutter.

**Cutting by Hand.**—Records were obtained on 103 farms where the corn was cut by hand. The labor required averaged 1.0 man hour per ton, or 5.9 man hours per acre. The average yield on these farms was 5.9 tons per acre. With a labor rate of 30c per hour, the cost of cutting in the field would average 30 cents per ton, or $1.77 per acre.

**Cutting with Sled Cutter.**—On only 17 farms were records obtained where the cutting was done with sled cutters. On these farms, it required an average of 0.7 man hour per ton, or 3.0 man hours per acre. The average of the yields on these farms was 4.3 tons per acre. The horse labor averaged 0.4 horse hours per ton, or 1.7 horse hours per acre.

Using a labor rate of 30 cents per hour for man labor and 11 cents per hour for horse labor, the cost of man labor was 21 cents per ton or 90 cents per acre and the cost of horse labor was 4.4 cents per ton or 19 cents per acre.

**Cost of Sled Cutters.**—On the basis of an original cost of $30 and a life of 20 years for a sled cutter, the following is an estimate of the average yearly cost.

Depreciation, 5% of $30 _____ _____$1.50

Interest, taxes, housing, repairs, (10% of ½ of

first cost)_____ 1.50

Total _____$3.00



Fig. 3.  Many farmers prefer the sled cutter, because of its simplicity and low first cost.

The 17 cutters included in this study cut an average of 18 acres per year, which would make the average cost of the sled cutters, 17 cents per acre or 4 cents per ton.

**Cutting Corn With Corn Binders.**—Figures on costs of cutting were obtained on 102 farms where the corn was cut by binders. On 83 of these farms the binder was pulled by horses, and on 19 by tractors.

Fig. 4.   Cutting corn with a binder saves considerable labor, and is preferred where the amount of corn to be cut is enough to justify the investment in a binder.

On those farms where the binder was pulled by horses, the man labor averaged 1.4 man hours per acre, or .27 man hours per ton, for operating the binder. The yield averaged 5.2 tons per acre on these farms. The horse labor for pulling the binder averaged 4.3 horse hours per acre, or .83 horse hours per ton.

The tractor labor for pulling the binder on the 19 farms that used tractors instead of horses, averaged 1.1 tractor hours per acre, or .22 tractor hours per ton. The yield for these farms averaged 5.1 tons per acre. The man labor for cutting the corn averaged 2.0 man hours per acre, or .39 man hours per ton, which is considerably higher than the average for those cases where the binder was pulled by horses. This is due to the fact that in most cases two men were used to do the cutting, one to operate the binder and one to drive the tractor. Where controls are so arranged that one man can operate both the tractor and the binder, the labor cost will be considerably lower and in most cases approximately

Fig. 5. A bundle elevator on the binder will eliminate much hard work, although it may not reduce the cost of silo filling.

half of that required when two men are used. If two binders are pulled by one tractor, as is practiced by a few farmers, the cost of cutting corn can be reduced even more.

**Fuel and Oil Costs for Tractor Pulling Binder.**—The fuel and oil costs for the tractors pulling the corn binders averaged as follows:

1.5 gallons of fuel per hour at an average cost of 13.2 cents per gallon, or 19.8 cents per hour;

.076 gallons of oil per hour at an average cost of 72 cents per gallon, or 5 cents per hour;

or a total cost for fuel and oil of 25 cents per hour.

**Tractor Overhead Charge.**—An overhead charge (including depreciation, interest, repairs, housing, and all costs except fuel, oil, grease, and labor for operating) of 50 cents per hour is assumed for the tractor. Best information indicates that if a farmer owns a tractor of two-plow size such as is commonly used for pulling corn binders, and if he manages it well and has a normal amount of work for it to do, it will probably cost him less than 50 cents per hour, exclusive of fuel, oil and labor for operating it.

**Total Cost of Tractor Power for Pulling Binder.**—On the basis of 50 cents per hour for overhead charges, and of 25 cents per hour for fuel and oil, which was the average for the 19 cases included in this report, the total cost of tractor power would be 75 cents per hour. Reducing this charge to an acre and ton basis, it becomes 83 cents per acre (1.1 tractor hours times 75), and 16 cents per ton (83 divided by 5.1 tons per acre.)

**Twine Cost.**—The twine used on the 129 farms cutting with corn binders, averaged .46 pounds per ton at an average cost of 12.8 cents per pound, or 5.9 cents per ton.

**Binder Costs (Machine Costs Only).**—The cost of owning and keeping the binder itself, is the largest variable in the cost of cutting corn with a binder. The average cost in 110 cases was 82 cents per acre and 16 cents per ton. These binders cut an average of 42 acres each per year. The cost of individual binders varied considerably from the average, however, the cost depending largely upon the acreage cut per year. Table 2 gives the average binder cost for binders cutting different acreages per year. The costs in Table 2 are computed as follows:

Annual depreciation = Purchase cost ÷ estimated life
in years
Interest = 7% of average value, (½ of cost new)
Housing, insurance, taxes = 1½% of cost new
Repairs = actual figures as reported.

Figure 6 graphically represents the various elements of binder cost for different acreages cut per year. The largest item of binder cost is depreciation. Repairs are rather a small item, averaging 6½ cents per acre for all of the binders.

**Total Cost of Cutting Corn With Binders.**—The total cost of cutting corn for a particular case, is determined by adding to the binder cost, the cost of the man labor, the cost of horse labor or tractor power, and the cost of twine. The total cost of cutting will vary considerably with the different acreages cut per year, just about as the binder cost varies

Table 2.—Corn Binder Costs

| Acres Cut Per Year | No. in Group | Average Purchase Cost | Average Age, Years | Average Acres Cut Per Year | Average Estimated Life, | | Annual Overhead Cost Per Acre | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Years | Acres | Depre-ciation | Int., Taxes, Ins., Housing | Repairs | Total |
| 1- 15 | 10 | $132.50 | 13.0 | 10.3 | 19.6 | 202 | $0.67 | $0.64 | $0.07 | $1.37 |
| 16- 30 | 37 | 172.64 | 9.0 | 24.0 | 16.0 | 384 | 0.45 | 0.36 | 0.08 | 0.89 |
| 31- 45 | 27 | 183.37 | 7.7 | 39.6 | 13.2 | 523 | 0.35 | 0.23 | 0.06 | 0.64 |
| 46- 60 | 14 | 189.61 | 5.2 | 51.4 | 11.0 | 565 | 0.33 | 0.18 | 0.05 | 0.57 |
| 61- 75 | 11 | 227.45 | 3.6 | 72.7 | 10.1 | 734 | 0.31 | 0.15 | 0.04 | 0.50 |
| 76- 90 | 6 | 205.83 | 4.5 | 83.3 | 11.1 | 925 | 0.22 | 0.12 | 0.03 | 0.38 |
| 91-105 | 3 | 201.66 | 7.7 | 100.0 | 16.0 | 1600 | 0.13 | 0.10 | 0.05 | 0.27 |
| 106-120 | 1 | 200.00 | 6.0 | 120.0 | 8.0 | 960 | 0.21 | 0.08 | 0.01 | 0.30 |
| 121-135 | 0 | ------ | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| 136-150 | 1 | 267.50 | 1.0 | 145.0 | 6.0 | 870 | 0.30 | 0.09 | 0.01 | 0.41 |
| Average of all binders | | 182.90 | 7.7 | 42.2 | 14.1 | 595 | | | 0.06½ | 0.82 |

**CORN BINDER COSTS**
**(AVERAGE OF 110 BINDERS)**
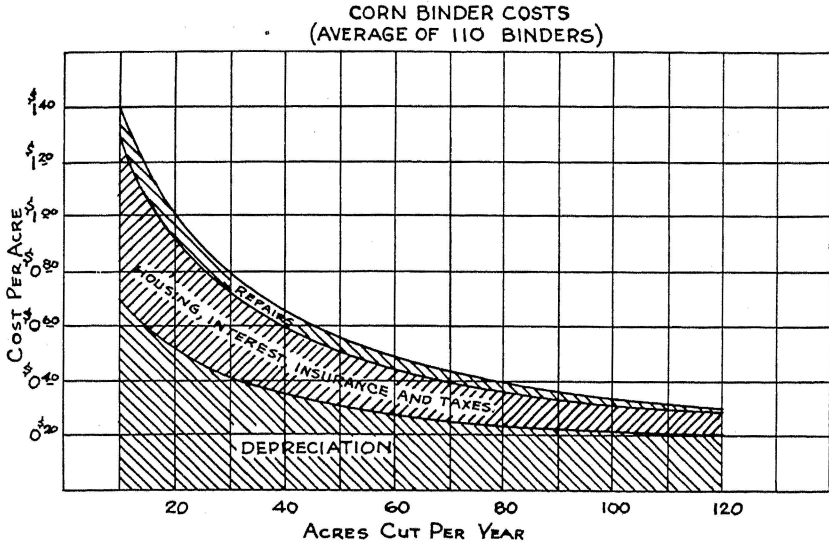
Fig. 6.—The average corn binder cost ranges from about $1.40 per acre where only 10 acres per year are cut, to about 30 cents per acre where as much as 120 acres per year are cut.

**ACRE COST OF CUTTING CORN WITH CORN BINDER**
**(YIELD — 5 TONS PER ACRE)**
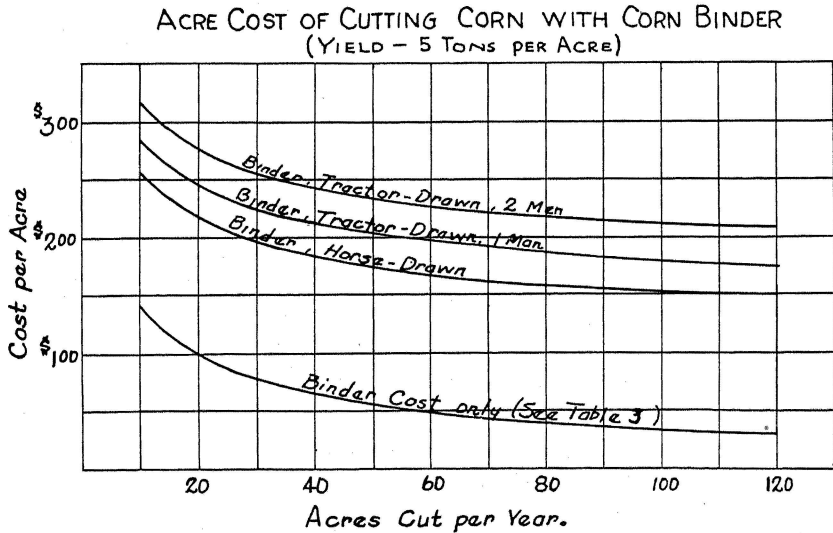
Fig. 7.—The total cost of cutting corn with a binder ranges from about $1.50 to about $2.50 per acre for horse-drawn binders, depending largely upon the number of acres cut per year.

for different acreages. Figure 7 shows the cost of cutting different acreages with binders. It is made up by adding to the cost of binders

shown in Figure 6, the average cost of labor, power, etc. to cut an acre by the different methods. Table 3 shows the same figures in tabular form.

TABLE 3.—ACRE COST OF CUTTING CORN WITH CORN BINDERS
(Yield, 5 Tons per Acre)

|  | Acres Cut Per Year | | | | | | |
|---|---|---|---|---|---|---|---|
|  | 10 | 20 | 40 | 60 | 80 | 100 | 120 |
| Cost of binder only[1] | $1.40 | $1.00 | $0.65 | $0.50 | $0.40 | $0.34 | $0.30 |
| Binder horse-drawn[2] | 2.59 | 2.19 | 1.84 | 1.69 | 1.59 | 1.53 | 1.49 |
| Binder tractor-drawn, 1 man[3] | 2.86 | 2.46 | 2.11 | 1.96 | 1.86 | 1.80 | 1.76 |
| Binder tractor-drawn, 2 men[4] | 3.19 | 2.79 | 2.44 | 2.29 | 2.19 | 2.13 | 2.09 |

1. From Figure 6 and Table 2.
2. Binder cost+1.4 man hours per acre at 30c+4.3 horse hours per acre at 11c+twine cost at 30c per acre.
3. Binder cost+twine cost+tractor cost of 1.1 tractor hours per acre at 75c per tractor hour+1.1 man hour per acre at 30c.
4. Binder cost+twine cost+tractor cost+2.2 man hours per acre at 30c per man hour.

**Bundle Elevator for Corn Binder.**—These studies do not include enough cases of cutting with corn binders equipped with bundle elevators to justify positive conclusions regarding costs or labor required. From a study of the few cases included, it appears that the use of a bundle elevator did not appreciably reduce the amount of labor required. The labor was probably easier to perform, however, as it is easier work to load bundles on a wagon after they are elevated than to pick them from the ground and lift them onto the wagon.

When a bundle elevator is used, the size of the silo filling crew should be so proportioned that it is just large enough to handle the corn as it is cut by the binder. It is important that the binder be kept running as any delay in the binder will cause time to be lost by the whole crew.

**Hiring versus Owning Binders.**—The average amount paid by 22 farmers hiring corn cut with binders was $1.49 per acre, not including twine. If we deduct from this figure an average labor charge of 1.4 man hours at 30 cents per hour, or 42 cents, and an average horse labor charge of 4.3 horse hours at 11 cents per hour, or 47 cents, then the charge for the use of the binder would be 60 cents per acre. This figure is 22 cents per acre lower than the average cost of the 110 owned binders included in this study.

The probable cost of owning and operating a binder could be determined from the curve in Figure 7. If this amount is more than the price for which a binder could be hired, then it would probably be cheaper to hire one rather than own one, provided it is possible to hire a binder at the time it is needed.

**Comparison of Different Methods of Cutting Corn.**—Table 4 gives a comparison of the labor and power required for the different methods of cutting corn, and Table 6 and Figure 8 give a comparison of the cost of cutting different acreages annually by different methods. Although the

Table 4.—Labor and Power Requirements for Cutting Corn by Different Methods

| | Man Hours | | Horse Hours | | Tractor Hours | |
|---|---|---|---|---|---|---|
| | Per acre | Per ton | Per acre | Per ton | Per acre | Per ton |
| Hand method, 103 cases, 5.9 tons per acre_ | 5.9 | 1.0 | | | | |
| Sled method, 17 cases, 4.3 tons per acre___ | 3.0 | .7 | 1.7 | .40 | | |
| Binder method, horse-drawn, 83 cases, 5.2 tons per acre_____ | 1.4 | .27 | 4.3 | .83 | | |
| Binder method, tractor-drawn, 19 cases, 5.1 tons per acre_____ | 2.0 | .39 | | | 1.1 | .22 |

Table 5.—Average Cost of Cutting Corn by Different Methods

| | Hand method, 103 cases, 5.9 T. per A. | | Sled method, 17 cases, 4.3 T. per A. | | Binder method, horse-drawn, 83 cases, 5.2 T. per A. | | Binder method, tractor-drawn, 19 cases, 5.1 T. per A. | |
|---|---|---|---|---|---|---|---|---|
| | Per A. | Per T. | Per A. | Per T. | Per A. | Per T. | Per A. | Per T. |
| Man labor, at 30c per hr._____ | $1.77 | $0.30 | $0.90 | $0.21 | $0.42 | $0.08 | $0.60 | $0.12 |
| Horse labor, at 11c per hr._____ | ---- | ---- | 0.19 | 0.04 | 0.47 | 0.09 | ---- | ---- |
| Tractor labor, at 75c per hr._____ | ---- | ---- | ---- | ---- | ---- | ---- | 0.83 | 0.17 |
| Sled cost, at 17c per acre | ---- | ---- | 0.17 | 0.04 | ---- | ---- | ---- | ---- |
| Binder cost, at 82c per A. (Avg. of 110 cases)_____ | ---- | ---- | ---- | ---- | 0.82 | 0.16 | 0.82 | 0.16 |
| Twine cost, at 5.9c per T. (Avg. of 129 farms)_____ | ---- | ---- | ---- | ---- | 0.31 | 0.06 | 0.30 | 0.06 |
| Total Cost | $1.77 | $0.30 | $1.26 | $0.31 | $2.02 | $0.39 | $2.55 | $0.51 |

Figures in this table are averages, based on average amounts and costs of man labor, horse labor, tractor power, and on average machine costs  It must be remembered that some farms have much higher costs and others much lower costs.

Table 6.—Comparison of Acre Cost of Cutting Corn by Different Methods for Different Acreages Cut per Year

(Yield, 5 Tons per Acre)

| | Acres Cut Per Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10 | 20 | 40 | 60 | 80 | 100 | 120 |
| Hand method _____ | $1.50[1] | $1.50 | $1.50 | $1.50 | $1.50 | $1.50 | $1.50 |
| Sled method_____ | 1.55[2] | 1.40 | 1.33 | 1.30 | 1.29 | 1.28 | 1.28 |
| Binder horse drawn_____ | 2.59[3] | 2.19 | 1.84 | 1.69 | 1.59 | 1.53 | 1.49 |
| Binder cost when credited with saving in labor_____ | 2.14[4] | 1.74 | 1.39 | 1.24 | 1.14 | 1.08 | 1.04 |

1. 1.0 man hours per ton✕5 tons per acre✕30 cents per man hours =$1.50.
2. $3.00 per year for sled cutter+4 cents per ton for horse labor+21 cents per ton for man labor. (See Table 5).
3. From Table 3.
4. Binder cost less 45 cents per acre credit as the value of bound over unbound corn in saving of labor in loading and hauling to the silo and running through the ensilage cutter. (Page 14).

binder method requires the least man labor, it is not the cheapest on the average for those farms included in these studies, unless it be credited with the saving in labor of handling the corn due to having it bound. In fact, it is on the average the most expensive method until it is credited with the saving in labor due to having the corn bound. With the binder method thus credited, it is cheaper on the average than the hand method where the acreage cut is more than about 30 to 35 acres per year, and it

COMPARISON OF ACRE COST OF CUTTING CORN BY DIFFERENT METHODS.
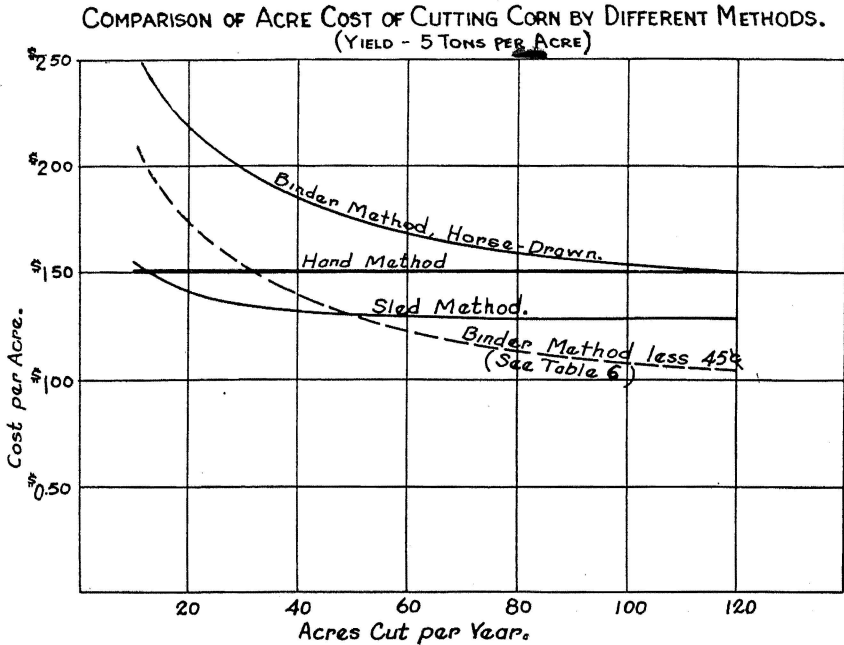(YIELD - 5 TONS PER ACRE)

Fig. 8.—On the average, the binder method is cheapest where more than about 50 acres per year are cut. The hand method of cutting is cheapest where less than about 12 acres per year are cut. The sled method is cheaper than the hand method where more than about 30 acres per year are cut.

is cheaper than the sled method for acreages above about 50 acres per year.

For acreages under 12 acres per year, the hand method of cutting is cheaper than the sled method, and for acreages above about 12 acres per year, the sled method is cheaper. It must be kept in mind that these conclusions are based on average figures obtained from the records included in these studies. Certain individual farmers have costs considerably below the average, while others have costs considerably above the average.

From a comparison of 128 cases of unbound corn and 122 cases of bound corn, it was found that the bound corn required an average of about .3 man hour per ton less than unbound corn, to load onto wagons, haul to the silo, and feed through the ensilage cutter. With man labor at 30 cents per hour, this saving would amount to 9 cents per ton, or 45 cents per acre with silage corn yielding 5 tons per acre. Bound corn is usually loaded onto wagons a little faster than unbound corn, and it is also unloaded and fed through the cutter somewhat faster. Therefore, horse labor for hauling is somewhat more efficiently used when the corn is bound. When this is considered, the difference in favor of bound corn

may be a little more than 45 cents per acre. When the cutter and engine are hired by the day, there will also be some saving in power and cutter costs due to the faster rate of filling when the corn is bound.

**Factors Other Than Cost.**—Although the cost of doing the work is probably the most important factor to consider in deciding upon which method of cutting to use, it is not the only factor that should be considered. The quality of the work done by the different methods, and the difficulty of the labor, as well as the amount of labor required, should be considered.

Cutting by hand is rather slow hard work, and it is generally to be recommended only where the total amount of corn cut is small and where good labor is available at a reasonable cost. In certain years, the corn may be blown down by storms and so badly tangled that a binder or sled cutter cannot be used to advantage. In such cases the corn probably should be cut by hand.

Operating a sled cutter is also hard work, although the total amount of labor required is less than if the corn is cut by hand. A sled cutter usually does not cut the corn as evenly as a binder. Some of the shorter stalks or some of the leaning stalks are apt to be cut high from the ground or missed entirely.

Cutting corn with a binder requires not only less labor, but it is easier labor to perform. A boy or an old man who can manage a team and a binder, can do as much work as any laborer. The objection is sometimes made that a binder knocks off some ears from the stalks. This disadvantage, however, is not serious.

## LABOR OF LOADING CORN, HAULING TO SILO AND FEEDING ENSILAGE CUTTER*

Several factors affect the amount of labor required to load the corn onto wagons, haul it to the silo, and feed it through the ensilage cutter. The main factors are the distance of haul, whether the corn is bound or unbound, the yield of the corn, the organization of the crew such as the number of men working as field loaders, the number at the wagon and cutter, etc., and the management of the crew.

**Bound Corn Requires Less Labor.**—As has been pointed out in the discussion of cutting corn in the field, bound corn requires less labor to load, haul to the silo, and feed into the cutter.

**Effect of Length of Haul on Labor Required.**—From an analysis of a number of labor records for various distances of haul from the field to the silo, it appears that the length of haul does not greatly affect the

*The conclusions presented in this section of the bulletin have been determined by statistical methods.

TABLE 7.—EFFECT OF DISTANCE OF HAUL ON LABOR OF LOADING,
HAULING AND FEEDING ENSILAGE CUTTER

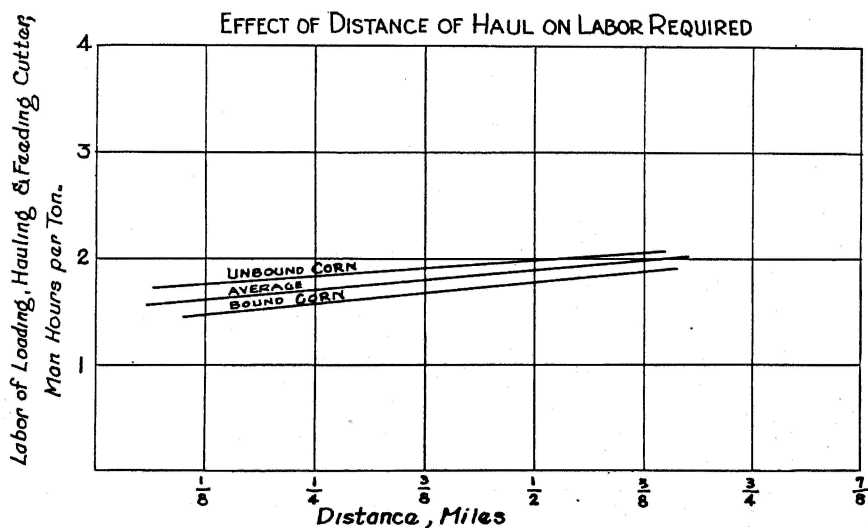| Distance Miles | Corn Bound or Unbound | No. Farms in Group | Average Man Hours per Ton |
|---|---|---|---|
| ⅛ | Bound | 18 | 1.22 |
| | Unbound | 23 | 1.79 |
| | | | Avg. 1.54 |
| ¼ | Bound | 53 | 1.61 |
| | Unbound | 58 | 1.82 |
| | | | Avg. 1.72 |
| ⅜ | Bound | 3 | 1.66 |
| | Unbound | 9 | 1.78 |
| | | | Avg. 1.75 |
| ½ | Bound | 16 | 1.76 |
| | Unbound | 22 | 1.93 |
| | | | Avg. 1.86 |
| ⅝ | Bound | | |
| | Unbound | 2 | 3.84 |
| ¾ | Bound | 5 | 1.40 |
| | Unbound | 3 | 2.45 |
| | | | Avg. 1.79 |
| 1 | Bound | 1 | 1.84 |
| | Unbound | 3 | 2.83 |
| | | | Avg. 2.58 |



Fig. 9.—Increasing the distance of hauling from a quarter mile to a half mile, increases the labor on the average about .15 man hour per ton. With labor at 30 cents per hour, this amounts to 4½ cents per ton.

cost of silage. (See Table 7 and Figure 9.) Increasing the distance of haul from a quarter mile to a half mile, increases the labor required on the average about .15 man hour per ton. At 30 cents per hour for labor this amounts to an increase in cost of 4½ cents per ton. Doubtless long hauls require slightly more horse labor also. Increasing the length of haul from a quarter to a half mile, would probably increase the cost of horse labor about 3 cents per ton, when horse labor is figured at 11 cents per horse hour. Where the distance of haul is very short, the labor required to load the corn onto wagons, haul it to the silo, and feed it through the cutter, averages about 1½ man hours per ton. Unbound corn requires slightly more labor, but the labor for both bound and unbound corn is affected to about the same degree by the distance of hauling.

**Effect of Use of Field Loaders on Labor Required.**—An analysis of the records included in these studies, shows that, in general, labor is slightly more efficiently used when a small number of field loaders, or when no field loaders, are used. (See Table 8 and Figure 10). This is doubtless due to several factors. With a larger number of field loaders, the chances are greater for loss of the field loaders' time waiting for empty wagons to return to the field. Also if two loaders work at the same wagon, they tend to get in each other's way, causing confusion and wasted effort.

TABLE 8.—EFFECT OF NUMBER OF FIELD LOADERS ON LABOR OF LOADING, HAULING AND FEEDING CUTTER

| No. of Field Loaders | Corn Bound or Unbound | No. Farms in Group | Avg. Rate of Filling T. per Hr. | Avg. Distance Hauled, Miles | Labor, Man Hours per T. |
|---|---|---|---|---|---|
| 0 | Unbound | 25 | 5.16 | .27 | 1.77 |
|   | Bound | 52 | 6.03 | .32 | 1.40 |
| 1 | Unbound | 7 | 5.30 | .24 | 1.56 |
|   | Bound | 10 | 4.96 | .23 | 1.49 |
| 2 | Unbound | 40 | 4.77 | .32 | 1.86 |
|   | Bound | 24 | 5.76 | .30 | 1.56 |
| 3 | Unbound | 9 | 5.17 | .40 | 2.57 |
|   | Bound | 13 | 5.86 | .31 | 1.76 |
| 4 | Unbound | 6 | 5.23 | .29 | 2.83 |
|   | Bound | 9 | 6.98 | .43 | 1.93 |

**Effect of Number of Men at Wagon and Cutter on Labor Required.**—Labor is used somewhat more efficiently when one man unloads from
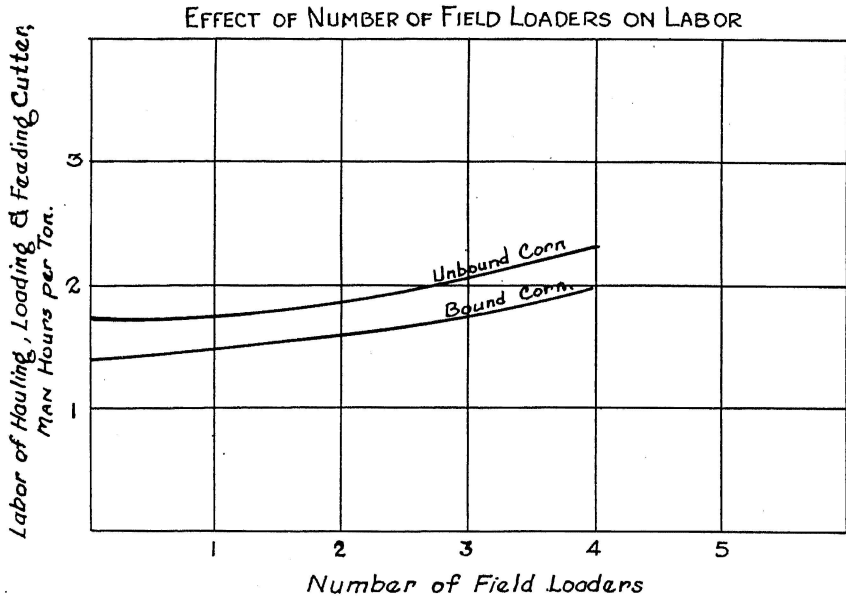
## EFFECT OF NUMBER OF FIELD LOADERS ON LABOR



Fig. 10.—Labor is somewhat more efficiently used where few or no field loaders are used.

the wagon and one man feeds the cutter, than when an additional man is used on the wagon. (See Table 9). In all except a few cases included in these studies, either two men or three men worked at the wagon and cutter. Using an extra man on the wagon to help unload makes it possible to run the corn through the cutter a little faster, but there is a slight increase in the labor required per ton. In the case of unbound corn, the use of three men at the wagon and cutter increased the labor of loading, hauling, and feeding the cutter on the average by about one tenth (.09) of a man hour per ton over that required when two were used; and in the case of bound corn, the increase was nearly two tenths (.18).

TABLE 9.—EFFECT OF THE NUMBER OF MEN AT THE WAGON AND CUTTER ON LABOR REQUIRED

| | No. of men at wagon and cutter | No. of farms in group | Avg. rate of filling, tons per hr. | Avg. distance hauled, miles | Labor, Man Hrs. per Ton | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | | | Feeding cutter | Loading, hauling and feeding cutter |
| Unbound | 2 | 41 | 4.71 | .32 | .26 | 1.88 |
| | 3 | 46 | 5.33 | .29 | .43 | 1.97 |
| Bound | 2 | 75 | 5.88 | .32 | .20 | 1.49 |
| | 3 | 34 | 6.13 | .31 | .38 | 1.67 |

Some farmers have been able to have one man unload from the wagon and feed the cutter by himself. An extension or side boards on the feed table enables one man to do the entire job very well by himself. Such an arrangement usually makes it possible to slightly reduce the amount of labor required per ton of silage, but the rate of filling may be reduced slightly also.

**Effect of Yield of Corn on Labor Required.**—The records included in these studies, indicate that slightly less labor per ton is required where the yield of corn in tons per acre is high. This is to be expected, because when the yield is low, the stalks usually vary considerably in size, making it more difficult to handle them, especially when the corn is not bound. Where yields are low, more driving and longer hauls are required to get a given amount of corn, and of course longer hauls increase the labor somewhat.

**Effect of Size of Crew on Labor Required.**—An analysis of the records included in these studies, indicate that the labor of loading the corn onto wagons, hauling it to the silo, and feeding it through the cutter, was not appreciably affected by the number of men engaged in these operations (loading, hauling, and feeding the cutter). The total labor required, except field cutting, however, was affected somewhat by the size of the crew (the total number of men engaged at silo filling work, except field cutting). There was a trend for the larger crews to be slightly less efficient, although not all large crews were inefficient, nor all small ones efficient. (See Table 10 and Figure 11.) This may be explained partly at least by the fact that many of the larger crews had extra men, such as trampers in the silo, and a man running the engine, who did not contribute a great deal to the total amount of work accomplished. It is more difficult generally to keep a large crew working efficiently. Delays due to machinery troubles, bad weather, and similar delays, mean a greater loss of time with large crews than with small ones.

## LABOR OF TRAMPING SILAGE

Although most farmers tramp their silage, it has been found that this is not necessary. Many farmers have found that their silage keeps just as well, and that they can get practically as much in their silos when no trampers are used. Many farmers who no longer tramp their silage, recommend that one man be kept in the silo to move the distributor pipe about and keep the silage evenly distributed. Some have found that even this one man is not necessary if the distributor pipe is tied in the center of the silo, and if a man can go up every hour or so and fork down the cone of silage that has accumulated in the center of the silo.

Table 10.—Effect of Size of Crew (Exclusive of Field Cutters) on Labor Required

| No. in Crew Excluding Field Cutters | Corn Bound or Unbound | No. of Farms in Group | Labor Exclusive of Field Cutting, Man Hours per Ton |
|---|---|---|---|
| 4 | Unbound | 2 | 2.10 |
| | Bound | 1 | 3.55 |
| 5 | Unbound | 4 | 2.83 |
| | Bound | 3 | 1.52 |
| 6 | Unbound | | |
| | Bound | 2 | 1.99 |
| 7 | Unbound | 5 | 1.70 |
| | Bound | 3 | 1.90 |
| 8 | Unbound | 14 | 2.36 |
| | Bound | 12 | 1.57 |
| 9 | Unbound | 11 | 2.48 |
| | Bound | 10 | 1.64 |
| 10 | Unbound | 22 | 2.41 |
| | Bound | 22 | 2.02 |
| 11 | Unbound | 16 | 2.73 |
| | Bound | 12 | 2.40 |
| 12 | Unbound | 20 | 2.36 |
| | Bound | 16 | 2.17 |
| 13 | Unbound | 7 | 2.18 |
| | Bound | 15 | 2.21 |
| 14 | Unbound | 8 | 3.33 |
| | Bound | 10 | 2.14 |
| 15 | Unbound | 5 | 2.97 |
| | Bound | 3 | 2.25 |
| 16 | Unbound | 7 | 2.55 |
| | Bound | 5 | 2.21 |
| 17 | Unbound | 1 | 1.64 |
| | Bound | 2 | 1.91 |

In 282 cases included in these studies, where labor records were complete, 17 used no trampers, 80 used one tramper each, 110 used two, 62 used three, 10 used four, and 3 used five. In the 265 cases where trampers were used, an average of .4 man hour per ton of silage was used for tramping. At 30 cents per hour, this amounts to 12 cents per ton. The highest 25% of these 265 cases used .7 of a man for tramping, and this would amount to 21 cents per ton. (See Table 1.)
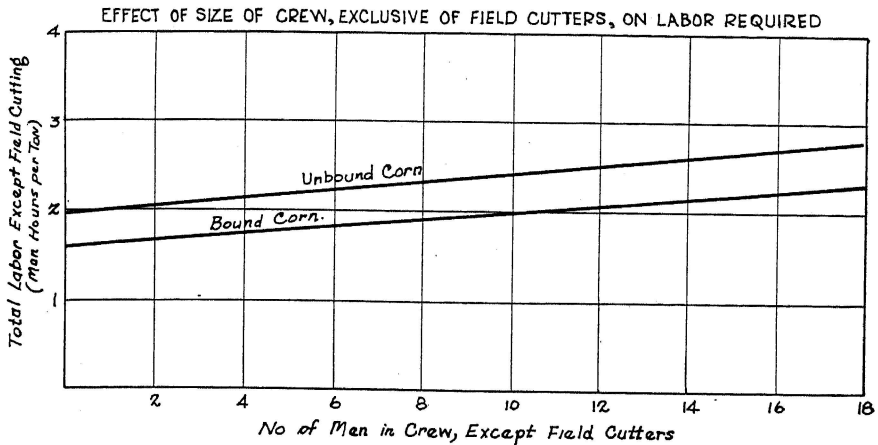
EFFECT OF SIZE OF CREW, EXCLUSIVE OF FIELD CUTTERS, ON LABOR REQUIRED



Fig. 11.—Large crews are generally less efficient than small ones, although not all large crews were inefficient, nor all small ones efficient.

## LABOR OF RUNNING THE ENGINE

Where an electric motor, a gas engine, or a tractor is used for power to drive the ensilage cutter, no operator is needed. A steam engine or a gas tractor without a governor should have an operator. In 260 cases where our records were complete, a man was used to operate the engine, requiring on the average .2 man hour per ton of silage. At 30 cents per hour, this represents a cost of 6 cents per ton. The highest 25% of these cases used an average of .35 man hour of labor per ton for operating the engine. This would amount to 10½ cents per ton at the rate of 30 cents per hour. (See Table 1.)

## MANY FARMERS PREFER A SMALL CREW

On the basis of only a very few records, it does not appear that the very small crews of two, three, and four men, are able to put up silage with much less labor per ton than larger crews. Practically all farmers who have filled with these small crews, however, are very enthusiastic about this method. With a small crew, the farmer does not have to be in such a hurry to get his morning chores done, nor will he have to work late into the night to do the evening work about the farm. He is not bothered with exchange labor. He can fill his silo when he is ready and just when his corn is at the best stage of maturity, rather than have to take his turn in a silo filling ring. With a small crew the silo is filled at a slower rate, giving more time for settling and consequently more silage put into the silo. The corn does not need to be cut down long ahead of time in the field. In fact, many of those using small

crews, go into the field with the wagons, cut the corn themselves, load it onto the wagons and take it to the silo and run it through the cutter. Two or three men with two wagons and teams can, by careful planning, fill a silo with a minimum of labor, and with a minimum of interference with the regular routine farm work. Another great advantage of the small crew is the ease with which it can be fed. It is quite a burden upon the farm women to prepare and serve meals for a large crew.

## EFFECT OF MANAGEMENT ON LABOR REQUIRED

Although in these studies, there was no way of definitely measuring or evaluating the effect of management of the silo-filling job, this factor is doubtless one of the most important ones affecting the amount of labor required. If the job is well planned, there will be a minimum of delay and lost time due to breakdown of machinery, and the crew will be so organized and proportioned that there will be a minimum of wasted effort and lost time. A good manager will also fill silos on days when the weather is favorable, unless of course there is a prolonged period of unfavorable weather at silo filling time.

## ENSILAGE CUTTER COSTS

The cost of the ensilage cutter, exclusive of power and labor to operate it, averaged 17.3 cents per ton cut for 173 cases where the cutter was owned and 18.7 cents per ton for 77 cases where the cutter was hired.

The cost of an ensilage cutter, like the cost of any other machine, varies considerably with the amount it is used per year. Table 10 gives the average cost of cutters included in this study, grouped according to the amount of ensilage cut per year. The average cost for the group cutting under 76 tons per year was 40 cents per ton; and the average cost for the group cutting from 451 to 600 tons per year was only 7 cents per ton.

Figure 12 shows the various items of the cost of ensilage cutters and how these items become smaller and smaller as the amount of use increases per year.

The cost figures of Table 11 and Figure 12 are made up as follows:

Annual Depreciation = Purchase cost ÷ estimated life
in years
Interest = 7% of average value (½ of cost new)
Housing, Insurance, Taxes = 1½% of cost new
Repairs = Actual figures as reported by owners.

**Whether to Own a Cutter or to Hire One.**—The answer to this question will largely depend upon whether a cutter can be hired at the time it is needed, and the amount it will cost to hire it. The cost of

TABLE 11.—ENSILAGE CUTTER COSTS

| Tons Cut Per Year | No. in Group | Average Purchase Cost | Average Age, Years | Average Tons Cut Per Year | Average Estimated Life | | Annual Overhead Cost Per Ton | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Years | Tons | Depre-ciation | Int., Taxes, Ins., Housing | Repairs | Total |
| 0- 75 | 15 | $226.17 | 8.7 | 61 | 18.9 | 1153 | $ .19 | $ .19 | $ .02 | $ .40 |
| 76- 150 | 37 | 264.00 | 8.9 | 118 | 19.8 | 2336 | .11 | .11 | .02 | .24 |
| 151- 300 | 61 | 276.89 | 9.4 | 244 | 17.6 | 4294 | .07 | .06 | .01 | .14 |
| 301- 450 | 30 | 303.00 | 7.8 | 390 | 14.2 | 5538 | .05 | .04 | .02 | .11 |
| 451- 600 | 16 | 297.81 | 9.1 | 550 | 16.9 | 9295 | .03 | .03 | .01 | .07 |
| 601- 750 | 8 | 378.00 | 6.5 | 706 | 15.5 | 10943 | .03 | .03 | .02 | .08 |
| 751- 900 | 3 | 288.00 | 11.3 | 800 | 19.7 | 15760 | .02 | .02 | .01 | .05 |
| 901-1050 | 0 | ------ | --- | ---- | --- | ---- | --- | --- | --- | --- |
| 1051-1200 | 1 | 400.00 | 3.0 | 1200 | 8.0 | 9600 | .04 | .02 | .01 | .07 |
| 1201-1350 | 0 | ------ | --- | ---- | ---- | ---- | --- | --- | --- | --- |
| 1351-1500 | 2 | 390.00 | 1.0 | 1450 | 7.0 | 10150 | .04 | .01 | .01 | .06 |
| Average all all cutters | | 283.09 | 8.7 | 305 | 17.3 | 5277 | .08 | .07 | .02 | .17 |

ENSILAGE CUTTER COSTS
(AVERAGE OF 175 CUTTERS)
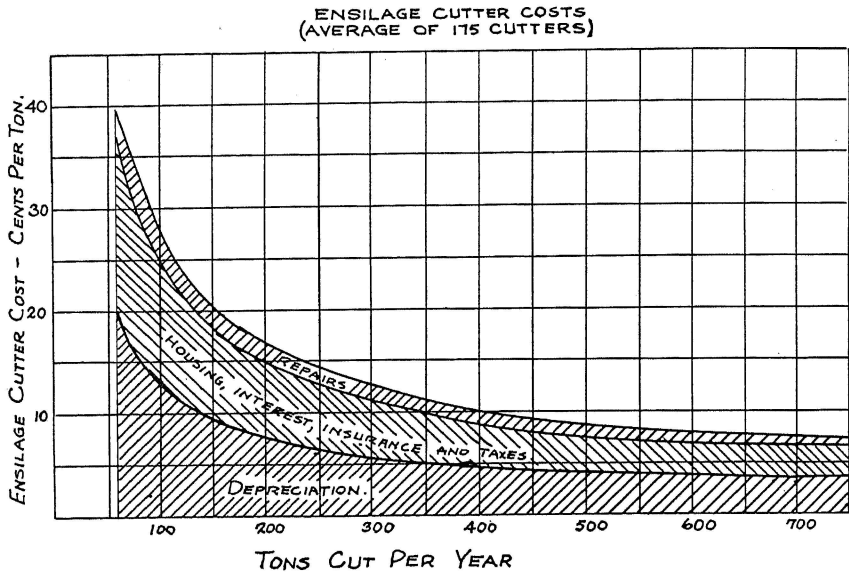


Fig. 12.—Ensilage cutter costs, exclusive of power and labor to operate them, vary from about 40 cents per ton where only 60 tons of ensilage are cut per year, to about 7 cents per ton where as much as 700 or 800 tons are cut annually.

owning a cutter can be estimated from Figure 12. For example, assume that 200 tons of ensilage is to be cut per year. From the curve it will be noted that the average cost for cutters cutting this amount annually, is 17 cents per ton. If a cutter can be hired at the time needed for this amount, it would be as cheap to hire as to own. If only 100 tons are cut per year, it will be noted from the curve that the cost of owning averages 28 cents per ton; therefore, if a cutter could be hired for say 20 cents per ton, it would be cheaper to hire one. It should be remembered that the figures presented here are average figures for 173 cutters included in this study. Some farmers by good management, reduce their cutter costs considerably below the average, while others have cutter costs considerably higher than average.

## COST OF POWER TO OPERATE ENSILAGE CUTTER

The average cost for power to operate ensilage cutters was as follows:

| Kind of Power | Number of Cases | Average Cost per Ton |
|---|---|---|
| Gas tractor, owned_____ | 104 | 20.2 cents |
| Gas tractor, hired_____ | 116 | 23.2 cents |
| Steam engine, hired_____ | 24 | 24.1 cents |

Fig. 13.—The small farm tractor has plenty of power to cut and elevate silage much faster than is usually necessary or desirable on the average farm, provided a good cutter is used and it is properly adjusted and is run at the correct speed.

In arriving at the cost of gas tractor power where it was owned, the overhead cost was assumed to be 50 cents per hour when the rate of filling was 7 tons per hour or less, and 60 cents per hour when it was more than 7 tons per hour. (See page 28). To the overhead cost was added the actual fuel and oil expense in each case. The wage of the tractor operator in those cases where operators were used, was counted in the labor costs and not in the power costs.

**Fuel and Oil Used.**—On 121 farms the fuel used by the tractor driving the ensilage cutter averaged .35 gallon per ton of ensilage cut; and on 113 farms the oil consumption averaged .02 gallon per ton, or a gallon for each 50 tons cut.

**Only Small Amount of Power Required to Operate Cutter.**—It has been found that it requires much less power to operate an ensilage cutter than is generally used. This is due to the fact that most cutters are commonly operated at higher speeds than necessary. And the power a cutter uses, increases tremendously as the speed is increased. At a test at the University of Wisconsin, it was found that when the speed was approximately doubled on a blower elevator type of ensilage cutter, the rate of filling was approximately doubled but the power used was increased seven times instead of being just doubled.* A cutter with a feed

*Agricultural Engineering, Vol. 6, Page 4, January, 1925.

table 14 to 16 inches wide has a capacity far greater than is needed on the average farm even when run at the slowest practical speed.

There is much less wear and tear on a cutter when it is operated at a slow speed, and of course its life will be increased considerably. It has been found that a good cutter running no faster than necessary and with the knives sharp and properly set, will cut and elevate the silage to a height of 35 or 40 feet at the rate of 5 tons per hour with only a 5-horse-power electric motor for power. It is true that an electric motor can carry a much greater temporary overload than a gasoline or kerosene engine. However, the smallest farm tractor is much more powerful than a 5-horse-power electric motor, and if a good cutter is used and is operated at the proper speed, the small tractor can cut and elevate silage as fast as is desired or necessary on the large majority of farms.

## THE FIELD ENSILAGE HARVESTER

The most common method of making silage is to cut the corn in the field by the hand, binder or sled method, then haul it to the silo, and run it through an ensilage cutter which cuts it and elevates it into the silo. Another method has been used to some extent in recent years. It is to use a field ensilage harvester. The machine, which is drawn through the field, cuts the corn into the proper lengths and elevates it into a wagon or truck drawn along side. The cut corn is then hauled to the silo and elevated into the silo by means of a blower-elevator. Only two cases of the use of the field ensilage harvester were included in these studies. It appears that some labor is saved by this method. The labor is doubtless easier to perform, as no heavy corn is cut or handled by hand. Also a boy or an old man who can drive a team can do as much work as any laborer. A higher investment in machinery is of course required with this method, and this would make the cost of machinery (per ton) higher than other methods where only small amounts of silage are put up. Like most other operations involving the use of considerable machinery, making silage with the field ensilage harvester becomes more economical for the larger amounts of work done. On the basis of only a very few records, it appears that on the average the field harvester method is somewhat cheaper (5 to 10 cents per ton) than other methods for amounts of silage above 200 tons per year. The management of the silo filling work, of course, is an important factor in determining the cost of making silage with a field ensilage harvester, as well as by other methods.

## VALUE OF CORN GOING INTO THE SILO

The largest single item of the total cost of silage is the cost of the corn itself. (See Figure 1.) The method of estimating the value of the

corn going into the silos in this study, was to allow 75 cents per acre for the stalks and 86 cents per bushel for the grain (the December 1929 farm price), less the community rate for husking. The owners' estimates of the yield of grain were used. On 233 farms where the records were complete, the cost of the corn going into silage averaged $4.73 per ton. The average yield on these farms was 5.3 tons of silage per acre. The average husking rate was 6 cents per bushel, making the average farm price of corn 80 cents per bushel.

## COST OF SILOS

The cost of 267 silos averaged 38 cents per ton of silage stored.

**Depreciation.**—About half the annual cost of a silo is for depreciation, which is figured by dividing the first cost of the silo by the estimated total life in years. The owners' estimates of the expected life were used in figuring the costs in these studies, with the exception that when the silo was estimated to last indefinitely or for a period longer than 50 years, a life of 50 years was assumed. Although many masonry silos will last longer than 50 years, it may be assumed that they should pay for themselves by the end of that time. The average of the owners' estimates on the life of the different types of silos, with the exception noted above, was as follows: For wood stave silos, 27 years; for various kinds of masonry silos, 45 years.

**Interest, Insurance, Taxes.**—Interest was figured at 5 per cent of the average value of the silo (half of the first cost). Insurance and taxes will vary considerably in different parts of the country. In many cases no insurance is carried by the farmer. Taxes and insurance in
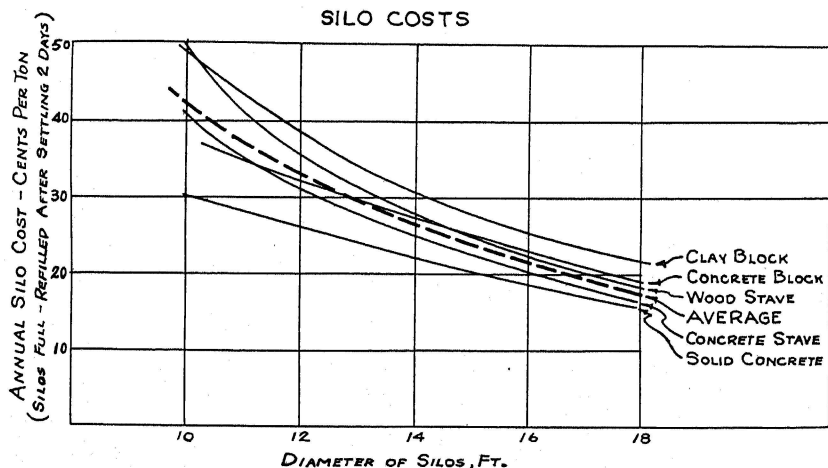


Fig. 14.—Silo costs per ton of silage stored are lower for the larger diameter silos.

these studies were figured together and at 2 per cent of the average value of the silo. These rates are doubtless ample for most cases.

**Repairs.**—Repairs on the silos included in this study varied considerably. Several instances of damage done by lightning and by storms necessitated rather high repair bills. On the other hand, many silos had been in use many years without any repair expense. The main items of repair expense were repairs to doors and roofs, painting, tightening hoops, plastering the inside, and repairs to the chute. The repair costs for the different types of silos averaged as follows:

| Type of Silo | Yearly Repair Cost, Cents per Ton |
|---|---|
| Wood Stave | 2.0 |
| Clay Blocks | 0.4 |
| Solid Concrete | 0.2 |
| Concrete Stave | 0.2 |
| Concrete Block | 0.6 |
| Brick | 0.8 |

**Cost of Different Types and Sizes of Silos.**—Table 12 gives the cost of the 240 silos grouped according to the type and size of the silos. Figure 14 presents the same data graphically. The wood silos and the clay block silos had slightly higher costs than the concrete silos. Solid concrete silos were the lowest in cost. It must be remembered that these figures are for only those silos upon which records were secured for these studies, and that the number of certain types and sizes of silos included were rather limited. These silos were not all of the same age, and therefore, part of the difference in cost may be explained by differences in material and labor costs at the time the silos were built. The principal item of silo cost, that of depreciation, is based upon the first cost of the silo and the owner's estimate of its total life, as explained on page 27. The cost of solid concrete silos will vary considerably in different localities due to difference in costs of sand, rock, and gravel. In some cases silos were constructed with farm labor, which was generally cheaper than contract labor. The cost of forms for solid concrete silos is another variable in their cost. In some instances forms were borrowed at little or no expense, while in other cases forms were rented or bought at considerable expense. In these studies all clay block silos were grouped together. There of course is considerable difference in quality and first cost of different grades of clay block silos but our data were not complete enough in most cases to enable further classification.

TABLE 12.—COST OF SILOS

| Type of Silo | Diam., Ft. | No. in Group | Avg. Height, Ft. | Avg. Capacity, Tons* | Avg. Tons Stored, 1929* | Avg. Est. Life, Yrs. | Avg. First Cost | Avg. Age, Yrs. | Silo Costs, Cents per Ton, When Full | | | | Silo Costs, Cents Per Ton, 1929 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Depreciation | Int., Ins., Taxes | Repairs | Total | |
| Wood Stave | 10' | 16 | 27.6 | 36.0 | 33.5 | 27 | $ 243 | 12.6 | $ .25 | $ .24 | $ .02 | $.51 | $.54 |
| | 12' | 37 | 30.5 | 59.9 | 53.8 | | 273 | 14.4 | .17 | .16 | | .35 | .39 |
| | 14' | 29 | 30.7 | 81.5 | 72.4 | | 321 | 14.3 | .15 | .14 | | .30 | .34 |
| | 16' | 4 | 34.8 | 128.3 | 109.5 | | 324 | 17.3 | .09 | .09 | | .20 | .24 |
| | 18' | 1 | 40.0 | 198.1 | 116.1 | | 480 | 16.0 | .09 | .08 | | .19 | .33 |
| Tile or Clay Block | 10' | 10 | 32.1 | 44.6 | 40.5 | 45 | 385 | 5.2 | .19 | .30 | .004 | .49 | .55 |
| | 12' | 19 | 36.5 | 76.8 | 63.3 | | 542 | 5.9 | .16 | .25 | | .41 | .49 |
| | 14' | 16 | 37.5 | 109.2 | 98.0 | | 580 | 7.3 | .12 | .19 | | .31 | .34 |
| | 16' | 13 | 42.8 | 171.8 | 140.0 | | 758 | 9.2 | .10 | .15 | | .25 | .31 |
| | 18' | 5 | 46.0 | 240.9 | 171.0 | | 930 | 10.3 | .09 | .13 | | .22 | .32 |
| | 20' | 4 | 47.8 | 313.6 | 229.0 | | 1000 | 14.0 | .07 | .11 | | .19 | .26 |
| Concrete Stave | 10' | 4 | 28.2 | 37.2 | 36.2 | 45 | 280 | 4.0 | .17 | .26 | .002 | .43 | .44 |
| | 12' | 17 | 33.9 | 69.6 | 61.6 | | 386 | 8.0 | .12 | .19 | | .31 | .36 |
| | 14' | 10 | 33.1 | 91.0 | 78.9 | | 455 | 7.7 | .11 | .17 | | .28 | .33 |
| | 16' | 5 | 41.0 | 161.7 | 150.0 | | 474 | 10.0 | .07 | .10 | | .17 | .18 |
| Concrete Block | 11' | 2 | 24.0 | 35.6 | 32.3 | 45 | 200 | 1.5 | .12 | .20 | .006 | .33 | .36 |
| | 12' | 4 | 33.0 | 67.0 | 60.1 | | 354 | 10.2 | .12 | .18 | | .31 | .34 |
| | 14' | 3 | 30.3 | 80.2 | 67.8 | | 400 | 12.3 | .11 | .17 | | .29 | .34 |
| | 16' | 2 | 47.0 | 195.8 | 160.6 | | 750 | 13.0 | .09 | .13 | | .23 | .28 |
| | 18' | 1 | 52.0 | 286.0 | 230.6 | | 900 | 14.0 | .07 | .11 | | .19 | .23 |
| Solid Concrete | 10' | 8 | 32.4 | 45.2 | 40.9 | 45 | 192 | 10.6 | .09 | .15 | .002 | .24 | .27 |
| | 12' | 8 | 31.9 | 63.8 | 60.6 | | 298 | 10.8 | .10 | .16 | | .26 | .28 |
| | 14' | 6 | 39.5 | 117.5 | 102.2 | | 433 | 14.5 | .08 | .13 | | .21 | .24 |
| | 16' | 13 | 38.9 | 145.1 | 121.6 | | 586 | 15.6 | .09 | .14 | | .23 | .28 |
| | 18' | 1 | 42.0 | 212.1 | 170.4 | | 400 | 17.0 | .04 | .07 | | .11 | .14 |
| | 20' | 2 | 49.0 | 324.6 | 275.9 | | 700 | 14.0 | .05 | .08 | | .13 | .15 |

*Capacities estimated from tables in Missouri Agricultural Experiment Station Circular 89.

Silo costs, expressed on a per ton basis, are considerably lower for the larger diameter silos. This is due, of course, to the fact that the larger diameter silos require proportionally less material per ton of capacity. (The volume or capacity of a silo varies with the square or second power of the diameter, and the material required to make the walls varies as the first power of the diameter). In building a silo, its diameter should not be determined by the cost per ton of capacity, however, but by the size of the herd that is to be fed and the daily ration.* In order to keep the silage fresh and from spoiling, it should be fed off at a rate of from 1½ to 3 inches per day. If the silage is fed slower than this, some of it will be apt to spoil on top, resulting in waste.

The most popular sizes of silos included in these studies are those with 12-foot and 14-foot diameters. The average age of the small diameter silos is less than the average age of the larger ones, indicating that most of the farmers building silos in recent years prefer the smaller sizes.

**Full Silos Mean Lower Costs per Ton.**—When a silo is filled only partly full, the silo cost per ton of silage stored is higher, because there are fewer tons over which the annual silo cost is distributed. To get the lowest possible cost per ton, therefore, the silo should be filled as nearly full as possible. Many farmers make it a practice to refill their silos after the silage has settled for a few days or a week.

For purposes of estimating the contents of silos, as reported in this bulletin, the tables in Missouri Agricultural Experiment Station Circular 89 were used.

*See Missouri Agricultural Experiment Station Bulletin 214.

## SUMMARY

1.   Records from 152 Missouri farms in 1929, indicate that silage costs average $6.65 per ton, 70 per cent of which is represented in the corn that is used in making silage.

2.   Exclusive of corn costs, the average cost of making silage was $2.00 per ton on these farms.   Labor costs represented 42 per cent of this amount, and power costs 25 per cent.   An attempt to lower silage costs should therefore be directed towards lowering labor and power costs.

3.   Silage costs on different farms vary widely.   While the average cost of making silage on 152 farms was $2.00 per ton, the average of the highest 25 per cent was $2.62 and the average of the lowest 25 per cent $1.42.   This indicates that some farmers are much more efficient than others, and that many of those with high costs could probably reduce their costs materially by the use of labor-saving machinery, where it will pay, and by careful planning and management.

4.   Figures on average costs for cutting corn in the field were as follows: Hand method, 103 cases, 30 cents per ton; sled method, 17 cases, 31 cents per ton; binder method, horse-drawn, 83 cases, 39 cents per ton; binder method, tractor-drawn, 19 cases, 51 cents per ton.   These figures are average figures.   Many farmers had lower costs, and many had higher costs.

5.   The binder method of cutting requires less labor, but machinery costs are higher.   Binder costs vary considerably with the amount of work done per year.   The average cost of 110 binders was 82 cents per acre, and 16 cents per ton.

6.   It requires less labor to handle bound corn than it does to handle unbound corn.   From these records it appears that an average of about 0.3 man hour per ton less labor is required to load the corn onto wagons, haul it to the silo, and feed it through the ensilage cutter, when it is bound.   At 30 cents per hour, this means a saving of 9 cents per ton.

7.   With all factors considered it appears from the records studied, that on the average the binder method is cheaper than the hand method where the acreage of corn cut is more than 30 to 35 acres per year, and that it is cheaper than the sled method for acreages above about 50 acres per year.

8.   For less than about 12 acres per year, the hand method is on the average cheaper than the sled method, and for more than about 12 acres the sled method is cheaper.

9.   An analysis of a number of records indicates that increasing the distance of haul from the field to the silo, from a quarter mile to a half

mile, increases the man labor about .15 man hour per ton. At 30 cents per hour, this amounts to 4½ cents per ton.

10. Large crews on the average were not quite as efficient as small ones.

11. Although most farmers tramp their silage, it has been found that this is not necessary. Many farmers are saving from 4 to 20 cents per ton by eliminating the work of tramping.

12. A gas tractor or electric motor that requires no operator is a saving over an engine or tractor that requires one.

13. Many farmers prefer the small crew. They fill their silos at a slower rate and get more silage in them. There is less interference with the regular farm work. They can fill when they are ready and when the corn is at the best stage of maturity. There is less lost time in case of a breakdown or delay. Serving meals to a small crew is much easier than to a large one. There is no bother about exchanging labor with neighbors.

14. Gas tractor power for operating the ensilage cutter averaged about 75 cents per hour, and about 20 cents per ton in those cases where farmers owned their tractors. 116 farmers hired gas tractors at an average of 24.1 cents per ton.

15. Fuel for the gas tractors averaged about one third of a gallon per ton of silage cut.

16. Most farmers use more power than is necessary to drive their cutters. A small farm tractor will cut and elevate silage as fast and as high as is necessary or even desirable on the great majority of farms, provided a good cutter is used, and it is properly adjusted, and driven at the proper speed. Most cutters are driven too fast.

17. Ensilage cutter costs averaged 17.3 cents per ton on 173 farms where the cutter was owned, and 18.7 cents per ton on 77 farms where the cutter was hired. The cost of a cutter on a per ton basis varies considerably with the amount cut per year.

18. The field ensilage harvester method of making silage requires less labor than other methods, but the machine cost is higher. On the basis of only a very few records, it appears that this method is slightly cheaper for amounts of silage greater than about 200 tons per year.

19. The average value of the corn going into the silos on 233 farms was $4.73 per ton. Grain was figured at 86 cents per bushel, less cost of husking.

20. Silo costs vary considerably on different farms. The average cost on 267 silos was 3 8 cents per ton of silage stored.

21. The nearer full a silo can be filled, the lower will be the silo charge per ton of silage stored.

22. The use of labor-saving machinery where it will pay, and proper management and organization of the silo filling crew, offer the best opportunity for reducing silo filling costs.