HAY AND ENSILAGE HARVESTING COSTS

C. L. DAY

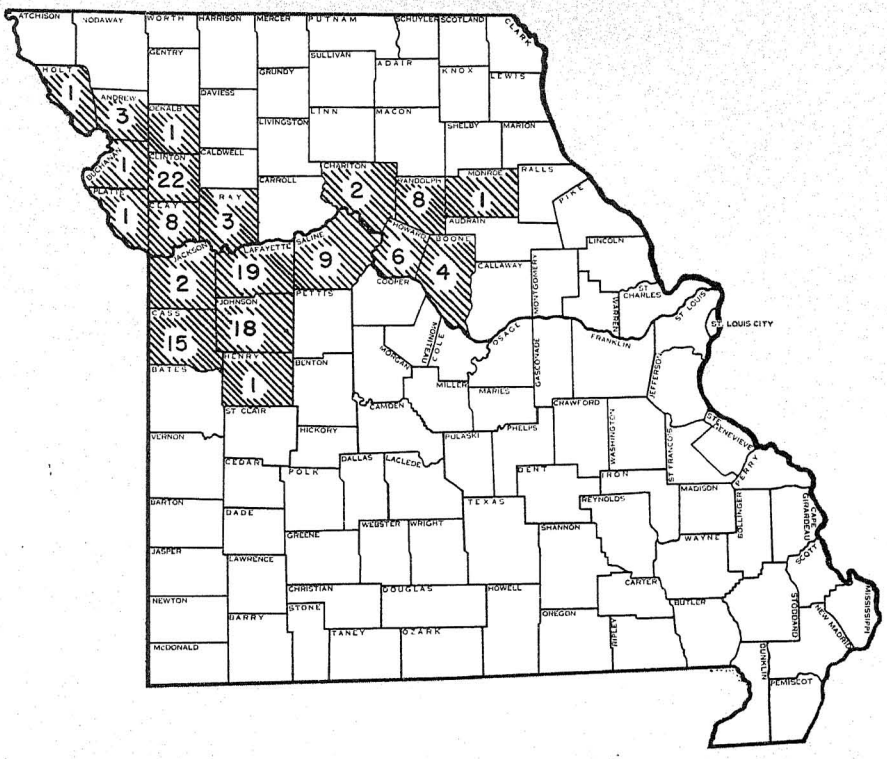

Figure 1.—A personal survey of farmers located in the shaded areas was made to obtain information for determining machinery costs. Numbers indicate the number of farmers interviewed within the county.

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TABLE 1--ESTIMATED AVERAGE COST
MACHINES USED IN HARVESTING HAY AND ENSILAGE
(Based on Survey in Areas Shown in Figure 1)

Machine	Purchase Cost (1950 basis)	Av. Use Per Year Hours	Probable Life Years	Cost Per Year [1]	Cost Per Hour [1]
Tractor, 1-Plow (10-13 rated DBHP)	$1250	800	12	$198	$0.25
Tractor, Light 2-Plow (14-17 rated DBHP)	1450	900	12	229	0.26
Tractor, Reg. 2-Plow (18-21 rated DBHP)	1800	1000	12	282	0.28
Tractor, 3-Plow (21-31 rated DBHP)	2150	1000	12	331	0.33
Mower, 7 ft. Tractor	270	100	12	52	0.52
Rake, Side Delivery (Steel Wheels)	250	65	13	41	0.63
Rake, Side Delivery (Rubber Tires)	375	95	9	73	0.77
Forage Harvester With Engine	1950	80	9	360	4.50
Forage Harvester Without Engine	1140	70	9	237	3.25
Ensilage Cutter Stationary	500	40	15	68	1.70
Forage Blower	400	70	12	60	0.86
Corn Binder	450	40	20	50	1.25
Wagon (Rubber Tires)	300	500	15	50	0.10
		Av. Use Per Year Tons			Cost Per Ton
Baler, Pick-up, With Engine, Automatic Tie	2400	700	8	530	0.76
Baler, Pick-up, Without Engine, Automatic Tie	1400	430	10	250	0.57
Baler, Pick-up, With Engine, Hand Tie	1650	470	10	300	0.64

[1] Costs include depreciation, repairs, interest, housing, taxes, and insurance, but do not include gasoline, oil, grease, wire, or twine.

Hay and Ensilage Harvesting Costs

C. L. Day

INTRODUCTION

Hay and ensilage harvesting are two operations common to many Missouri farms. The methods used in harvesting these crops have been affected by the development of new harvesting machines, the replacement of horse power with tractor power, and the cost and availability of labor. Many farmers have been forced to consider carefully the method best suited to their particular farms. Some must decide whether to buy machinery or to depend upon custom operators to do the bulk of their harvesting.

The purpose of the investigation described herein was to determine the costs of operating various machines used in harvesting hay and ensilage. With this information a farmer should be better able to select the method of harvesting best suited to his farm.

METHOD AND SCOPE OF INVESTIGATION

The information herein reported was obtained in the years 1948 to 1950 by a personal survey of farmers in a number of counties in the central and western parts of Missouri. The farmers were asked to supply the following information for each of their hay or ensilage harvesting machines: make, model and size of machine, age, new cost, estimated years of life, repair costs, days used per year, and average capacity of the machine. In order to determine the cost of harvesting by various methods, farmers were asked to estimate the man, machine, and tractor hours required for each operation involved in harvesting.

THE COSTS

The costs involved in harvesting hay and ensilage have been broken down into labor, machine and power (tractor) costs. The cost of power to operate auxiliary engines on balers and field harvester has been included as machine costs since it would be very difficult to separate the two costs.

Labor costs which appear in the tables are computed at the rate of 75¢ per hour regardless of the age of the worker or the type of work being done.

Table 1 gives the estimated average cost of a number of machines used in harvesting. These costs include depreciation, repairs, interest, housing, taxes, and insurance. Annual depreciation is simply the first cost divided by the probable years life. Estimates of repair costs were made by the individual farmers interviewed and these were used as a basis for determining repair costs for the different machines. Their estimates included costs of

TABLE 2--APPROXIMATE FUEL CONSUMPTION OF TRACTORS AND ENGINES USED IN HARVESTING HAY AND ENSILAGE

Tractor or Engine	Gals. Fuel Per Hour
Auxiliary engine on baler	1 1/4
Tractor pulling baler with engine	1 1/2
Tractor pulling power-take-off baler	2
Auxiliary engine on field harvester	2
Tractor pulling field harvester with engine	1 1/4
Tractor pulling power-take-off field harvester	2 1/2

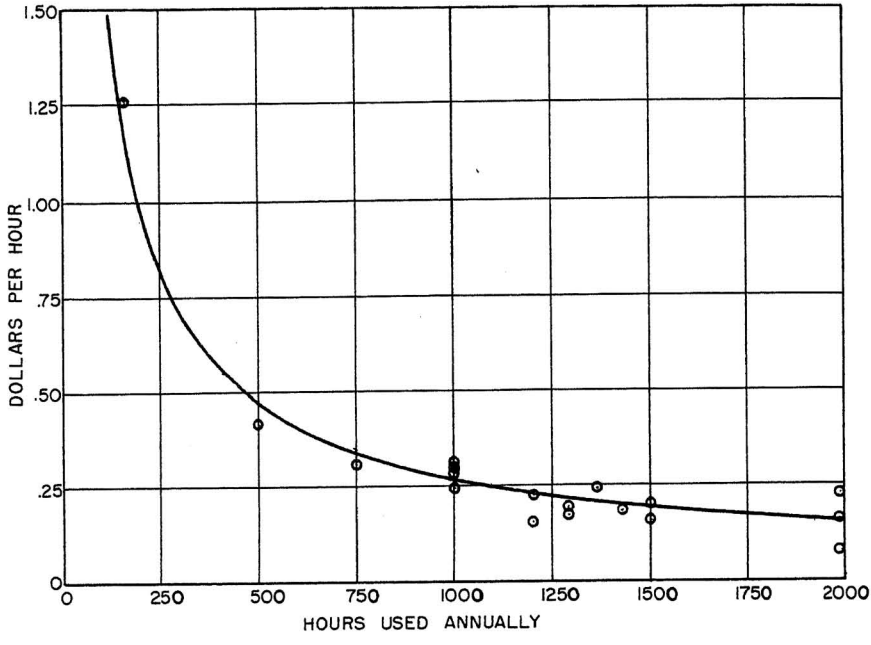

Figure 2.—Relationship between annual use and cost per hour (exclusive of fuel and oil) for 2-plow tractors. Each circle represents one machine.

both labor and parts. Interest was computed at 6 per cent on one-half of the first cost. A charge of approximately 7¢ per square foot of storage space required was made for housing. Taxes and insurance costs were estimated at 2 per cent on one-half the first cost. The first cost of the machines listed is based on prices in 1950 and is an average of all machines of the particular type and size. The costs in Table 1 do not include the cost of gasoline, oil, grease, twine, or labor to operate the machine.

Average tractor costs are also given in Table 1. Again the cost of fuel, oil, and grease is not included. The amount of fuel used per hour depends upon the size of the tractor, the load being pulled, and the age and condition of

the tractor. In general, however, a 1-plow tractor will use about 1 gallon per hour, a light 2-plow tractor from 1 to 1¼ gallons per hour, a regular 2-plow tractor from 1¼ to 1½ gallons per hour and a 3-plow tractor from 2 to 2½ gallons per hour.

The average fuel consumption of tractors and auxiliary engines used to operate pick-up balers and field harvesters is given in Table 2.

The cost per hour and per year given in Table 1 are average costs, and the cost of a particular machine may differ considerably from the average. The annual cost of a machine is often affected only slightly by the number of hours used each year, but the daily or hourly cost is greatly affected. Thus, machines which are used fewer hours per year than the average shown in Table 1 will have a higher hourly cost and those used more than the average will have a lower hourly cost. The relationship between hourly cost of 2-plow tractors and their annual use is shown in Figure 2.

HAY HARVESTING OPERATIONS

The average rate of performing various hay harvesting operations is given in Table 3 and the average cost per ton in Table 4. It will be noted that the machine costs listed in Table 4 are higher than those listed in Table 1. The cost of fuel for the auxiliary engine (where used), and the cost of bale ties, oil and grease for the machine have been included in Table 4. The cost of fuel, oil and grease for the tractor has been included in the power (tractor) costs in Table 4.

In general, more hay can be handled with a pick-up baler than with a hay chopper. Automatic tying pick-up balers with auxiliary engines have the highest capacity and are usually more satisfactory where much custom work is to be done. These machines, of course, have a high first cost. Power take-off models have a lower first cost and also a lower operating cost. They are not as satisfactory under some operating conditions as models with auxiliary engines. Models with auxiliary engines but without automatic tying devices have a relatively low first cost, but require more labor to operate.

The use of field harvesters for chopping hay has thus far been quite limited in Missouri. Some of the objections offered by farmers are as follows: (1) The capacity of a field harvester for chopping dry hay is relatively low. (From Table 3 the average rate of chopping is 2.9 tons per hour as compared with 3.5 to 3.8 tons per hour for baling.) (2) When dry hay is blown into the barn the stems tend to separate from the leaves. (3) Chopped hay cannot be fed conveniently unless fed at or near the place of storage.

Field choppers with engines have little or no higher capacity than models operated by power take-off when used for chopping hay, but will operate more satisfactorily where windrows are uneven.

Mowing. No data were collected on horse-drawn mowers and apparently

TABLE 3--AVERAGE RATES OF PERFORMING VARIOUS HAYING OPERATIONS

Operation	Machine	Acres Per Hr.	Man Hrs. Per Acre	Machine Hours Per Acre	Tractor Hours Per Acre
Mowing	7 ft. tractor mower	2.5	0.4	0.4	0.4
Raking	Side delivery rake	3.1	0.32	0.32	0.32
		Tons Per Hr.	Man Hrs. Per Ton	Machine Hours Per Ton	Tractor Hours Per Ton
Baling hay	Automatic-tie pick-up baler with engine	3.8	0.26	0.26	0.26
Baling hay	Automatic-tie pick-up baler without engine	3.6	0.28	0.28	0.28
Baling hay	Hand tie, pick-up baler with engine	3.5	0.86	0.29	0.29
Hauling and storing baled hay	Wagons and tractors 1/	2.45	1.4	0.41	0.41
	Trucks	2.5	1.5	0.40	----
Chopping hay	Field chopper with engine	2.9	0.35	0.35	0.35
Chopping hay	Field chopper without engine	2.9	0.35	0.35	0.35
Hauling chopped hay	Wagons and tractors	2.9	0.52	1.05	0.35
Elevating chopped hay	Blower	3.0	0.49	0.33	0.33

1/ Average size of crew, 3 to 4 men.

there were not many in use in the areas covered by the survey. Practically all farmers who were interviewed were using 7-foot tractor mowers.

Table 5 gives the ranges and averages of rates of performance and costs of mowing hay. Those in the fast third were usually but not always in the low-cost third. Some in the high-cost group were there because they used the mower only a few hours per year rather than because of a slow rate of operation. Figure 3 shows the relationship between annual use and cost per hour or per acre. The costs shown in Figures 3 include depreciation, repairs, interest, housing, taxes and insurance. The average cost for repairs, including sharpening costs, was about 7¢ per acre.

Raking. The only type of rake for which data were obtained was the tractor-drawn side delivery rake. Since nearly all farmers interviewed were using either a baler or field harvester, this was about the only type rake being used. Models with rubber tires have a considerably higher first cost than those with steel wheels, and also a higher annual cost as shown in Table 1.

There was apparently little difference in the rates of performance of

TABLE 4--AVERAGE COST FOR VARIOUS HAYING OPERATIONS

Operation	Machine	Labor Costs Per Acre	Machine 1/ Costs Per Acre	Tractor 2/ Costs Per Acre	Total Cost Per Acre
Mowing	7 ft. tractor mower	$0.30	$0.21	$0.24	$0.75
Raking	Side delivery rake	0.24	0.25	0.19	0.68
		Cost Per Ton	Cost Per Ton	Cost Per Ton	Cost Per Ton
Baling hay	Automatic-tie, pick-up baler with engine	0.20	1.74	0.17	2.11
Baling hay	Automatic-tie, pick-up baler without engine	0.21	1.27	0.20	1.68
Baling hay	Hand tie, pick-up baler with engine	0.65	1.49	0.18	2.32
Hauling and storing baled hay	Wagons and tractors	1.05	0.04	0.20	1.29
	Trucks	1.12	0.70	----	1.82
Chopping hay	Field chopper with engine	0.26	1.55	0.20	2.01
Chopping hay	Field chopper without engine	0.26	1.05	0.30	1.61
Hauling chopped hay	Wagons and tractors	0.39	0.10	0.21	0.70
Elevating chopped hay	Blower	0.37	0.28	0.20	0.85

1/ Includes cost of gasoline, oil, grease for auxiliary engines and the cost of twine or wire for balers.

2/ Includes cost of gasoline, oil and grease.

TABLE 5--RANGES AND AVERAGES OF RATES OF PERFORMANCE AND COSTS OF MOWING AND RAKING HAY

Machine	No. of Mach.	Acres per hour			Costs per acre		
		Slow Third	Fast Third	Av. all Operators	High Cost Third	Low Cost Third	Av. all Operators
Mower, 7 ft. tractor drawn	62	2.1	3.0	2.5	$0.92	$0.62	$0.75
Rake, side delivery, tractor drawn	54	2.4	3.8	3.1	$0.95	$0.51	$0.68

rakes with rubber tires and those with steel wheels, and they are therefore not considered separately in Table 5. Figure 4 shows the relationship between annual use and cost per hour and per acre for side delivery rakes with steel wheels. Figure 5 shows the same relationship for rakes with rubber tires.

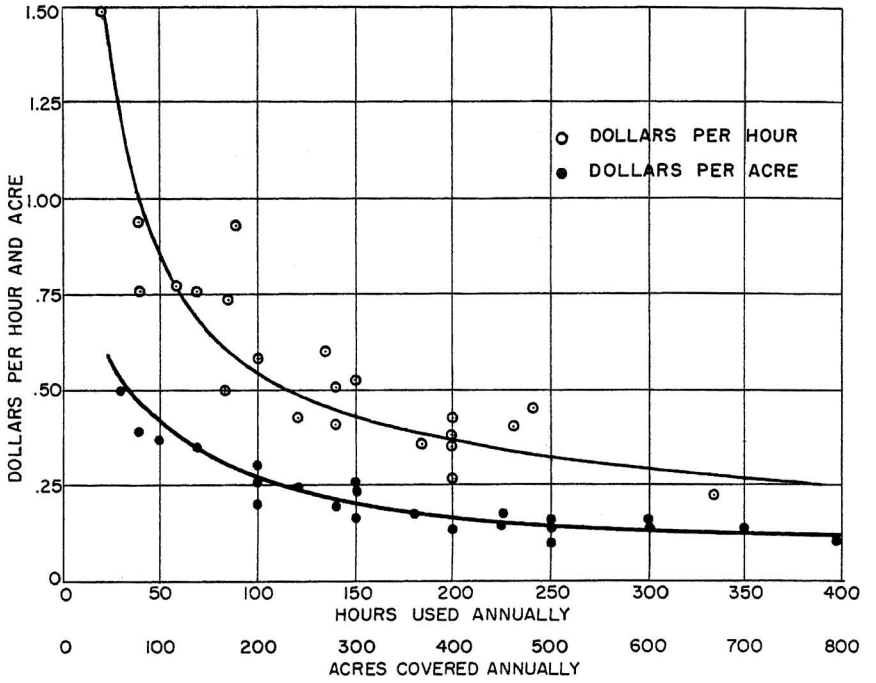

Figure 3.—Relationship between annual use and machine cost per hour and per acre for a 7-foot tractor mower. Each circle or dot represents one machine.

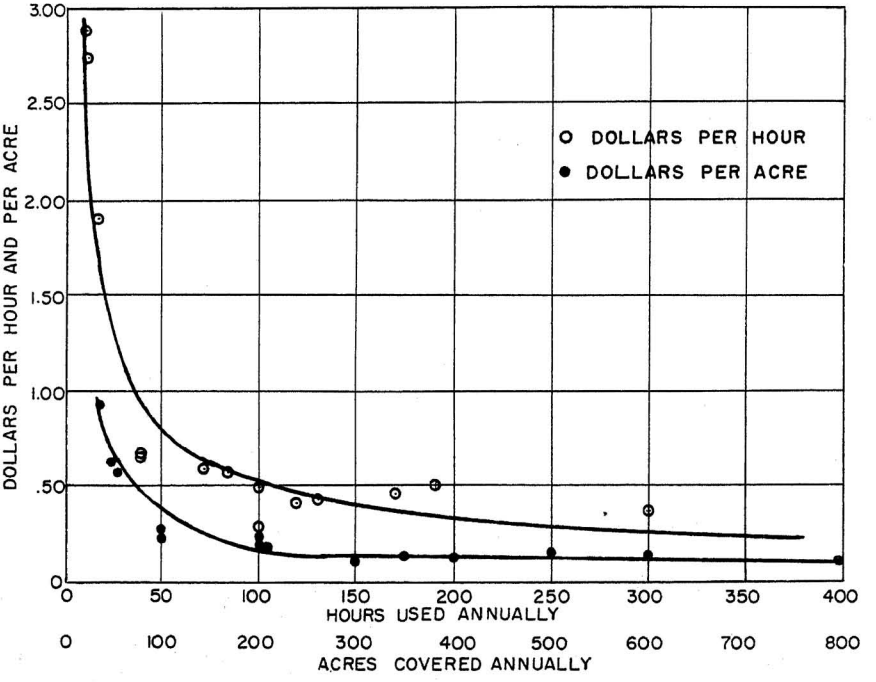

Figure 4.—Relationship between annual use and machine cost per hour and per acre for a side delivery rake with steel wheels. Each circle or dot represents one machine.

The costs shown in Figure 4 and Figure 5 include depreciation, repairs, interest, housing, taxes and insurance. The average repair cost for all side delivery rakes was about 4¢ per acre covered.

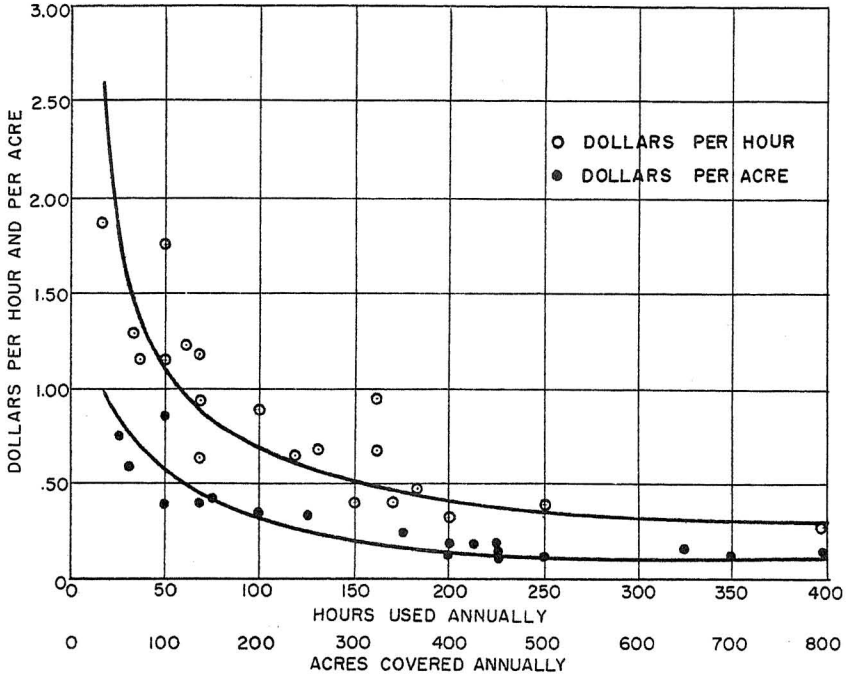

Figure 5.—Relationship between annual use and machine cost per hour and per acre for a side delivery rake with rubber tires. Each circle or dot represents one machine.

Baling. Three general types of pick-up balers were included in the survey. They are automatic tying balers with engines, automatic tying balers operated by power take-off, and hand-tie balers with engines. The cost and performance data are presented on a tonnage basis rather than on the basis of hours or acres of use. Figures 6, 7, and 8 show the relationship between machine costs and tons baled per year. The costs include depreciation, repairs, interest, housing, taxes and insurance for the baler, but do not include the cost of bale ties, gasoline for the auxiliary engine nor oil and grease. The average cost for repairs for 33 automatic tying balers with engines was 18¢ per ton baled; for 24 automatic tying balers without engines about 13¢ per ton baled; and for 16 hand-tie balers about 10¢ per ton. The average cost for twine for 32 balers was 73¢ per ton. The wire for nine automatic wire-tying balers cost an average of 66¢ per ton and for 13 hand-tie balers 60¢ per ton. The cost of bale ties for all types of balers ranged from 50¢ to $1.00 per ton and the average for 54 balers was 68¢ per ton.

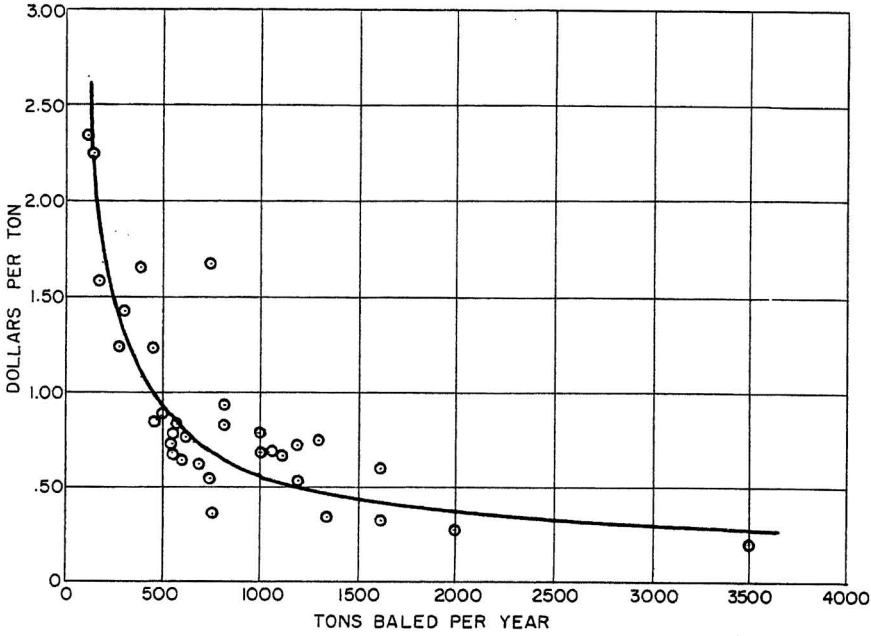

Figure 6.—Relationship between tons baled per year and machine cost per ton for an automatic tying pick-up baler with engine. Each circle represents one machine.

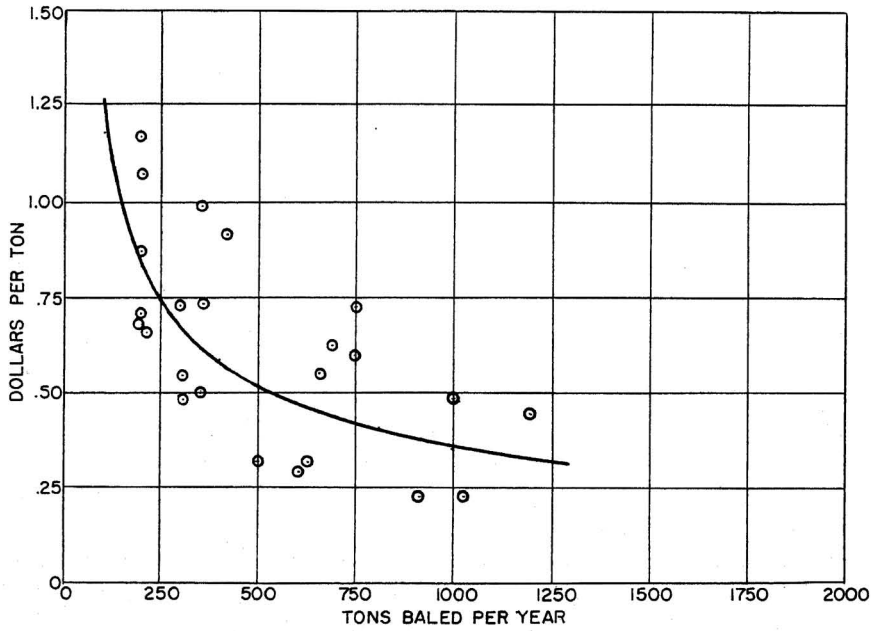

Figure 7.—Relationship between tons baled per year and machine cost per ton for an automatic tying pick-up baler without engine. Each circle represents one machine.

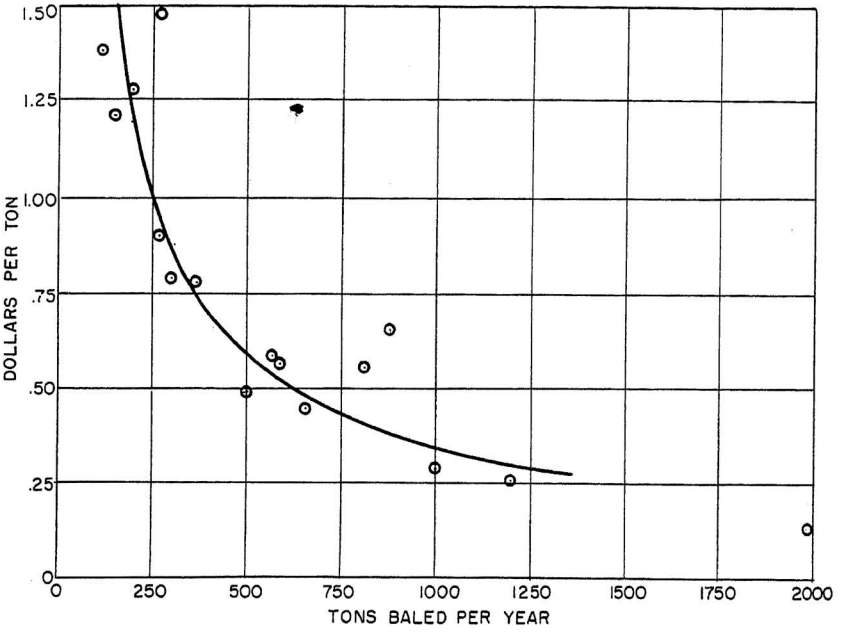

Figure 8.—Relationship between tons baled per year and machine cost per ton for hand tie pick-up baler with engine. Each circle represents one machine.

TABLE 6--RANGES AND AVERAGES OF RATES OF PERFORMANCE AND COSTS OF BALING HAY

Type of Baler	No. of Mach.	Tons Per Hour			Cost Per Ton		
		Slow Third	Fast Third	Av. All Operators	High Cost Third	Low Cost Third	Av. All Operators
Pick-up, automatic tying, with engine	33	2.9	4.8	3.8	2.70	1.65	2.11
Pick-up, automatic tying, without engine	24	2.9	4.4	3.6	2.02	1.37	1.68
Pick-up, hand tie, with engine	16	2.6	4.4	3.5	3.01	1.71	2.32
Custom Baling Charges (all types of pick-up balers)	14				5.25	3.59	4.41

The ranges and averages of rates of performance and costs of baling hay are given in Table 6. Those in the slow third were not always in the high-cost third nor were those in the fast third always in the low-cost third. The annual use of the machine usually affected the total cost of baling more than did the rate of baling. The variation in the cost of baling with power take-off model balers was due in part to the wide range in the price of balers of this

TABLE 7--RANGES AND AVERAGES OF RATES OF PERFORMANCE AND COSTS OF CHOPPING HAY WITH FIELD HARVESTERS

Type of Machine	No. of Mach.	Tons Per Hour			Cost Per Hour		
		Slow Third	Fast Third	Av. All Operators	High Cost Third	Low Cost Third	Av. All Operators
Field harvesters, all types	12	2.31	3.81	2.89	$2.45	$1.20	$1.89

type. Some balers of this type sold for as little as $1150 in 1950 while others sold for more than $2000. This accounts for some of the wide scatter of points about the curve in Figure 7.

Chopping Hay With Field Harvester. Twelve of the farmers interviewed reported that they had harvested some hay using a field harvester. The most harvested by this method by one operator was 200 tons and the average per operator was about 75 tons. The average rates of performance and costs of chopping hay with field harvesters are given in Table 7. No differentiation is made between machines with engines and those without in this table.

Curves showing the relationship between cost per hour and hours annual use for field harvesters are included in the discussion of ensilage harvesting which follows.

Hauling and Storing Hay. The average rate of hauling and placing baled hay in storage is given in Table 3 and the average cost in Table 4. The rate and cost depend upon the size of crew, the distance from the field to the place of storage and the method of loading and unloading the hay. The average size of crew was 3 or 4 men and a crew of this size could haul and place in storage about 2½ tons of baled hay per hour using a tractor and a wagon for hauling. The rate of hauling and placing baled hay in storage can be increased by (1) trailing a wagon behind the baler and allowing the baler to push the bales onto it, (2) bunching the bales by means of a trailing hay slide, (3) use of a bale loader for loading, (4) use of hay sling or bale elevator for unloading.

The average rate of hauling and elevating chopped hay is given in Table 3 and the average cost in Table 4. The average size of crew was three men and a crew of this size could haul and store about 2.9 tons per hour using either a tractor and three wagons or two trucks to haul and a tractor and blower to elevate. The hay was unloaded into the blower by using a tractor or winch to pull a false end gate through the wagon. In nearly all cases the blower could handle the hay faster than it could be chopped and hauled.

ENSILAGE HARVESTING OPERATIONS

The average rate of performing various ensilage harvesting operations is given in Table 8 and the average cost per ton in Table 9. The costs for fuel, oil and grease are included in the machine and tractor costs listed in

TABLE 8--AVERAGE RATE OF PERFORMING VARIOUS ENSILAGE HARVESTING OPERATIONS

Operation	Machine	Tons Per Hour	Man Hours Per Ton	Machine Hours Per Ton	Tractor Hours Per Ton
Cutting	Corn binder	6.4	.16	.16	.16
Loading and hauling bundles	Wagons and tractors [1]	8.6	1.10	.58	.46
Chopping and elevating	Stationary ensilage cutter	8.6	.35	.12	.12
Chopping	Field Harvester with engine	7.4	.13	.13	.13
Chopping	Field Harvester without engine	7.3	.14	.14	.14
Hauling chopped silage	Wagons	6.4	.30	.41	.25
	Trucks	7.0	.36	.28	---
Elevating	Forage blower	6.7	.37	.15	.17

[1] Average size of crew, 9 men.

TABLE 9--AVERAGE COST PER TON FOR VARIOUS ENSILAGE HARVESTING OPERATIONS

Operation	Machine	Labor Cost Per Ton	Machine [1] Cost Per Ton	Tractor [2] Cost Per Ton	Total Cost Per Ton
Cutting	Corn binder	$.12	$.30	$.13	$ .55
Loading and hauling bundles	Wagons and tractors	.83	.06	.21	1.10
Chopping and elevating bundles	Stationary ensilage cutter	.26	.20	.09	.55
Chopping	Field harvester with engine	.10	.70	.10	.90
Chopping	Field harvester without engine	.11	.49	.13	.73
Hauling chopped ensilage	Wagon	.22	.04	.12	.38
	Trucks [3]	.27	.49	---	.76
Elevating	Forage blowers	.28	.13	.12	.53

[1] Machine costs include cost of twine, fuel, oil and grease where used.

[2] Tractor costs include the cost of fuel, oil and grease.

[3] Trucks were charged at the rate of $1.75 per hour.

Table 9. The average fuel requirement for performing some of these operations is given in Table 2.

Cutting With Corn Binder. Not many of the farmers interviewed were using a corn binder for cutting corn to use for silage. This method is still used profitably by some farmers who harvest only enough silage to fill one or two silos per year and by those who cannot hire a field chopper to

TABLE 10--RANGES AND AVERAGES OF RATES OF PERFORMANCE AND COSTS FOR CUTTING AND CHOPPING ENSILAGE

Machine	No. of Mach.	Tons Per Hour			Cost Per Ton		
		Slow Third	Fast Third	Av. all Operators	High Cost Third	Low Cost Third	Av. all Operators
Corn binder, tractor drawn	5	5.1	7.9	6.4	$ .60	$.32	$.45
Forage chopper, stationary	5	7.2	9.6	8.6	.61	.48	.55
Field harvester without engine	26	6.2	8.7	7.3	1.01	.51	.73
Field harvester with engine	15	5.9	9.0	7.4	1.12	.70	.90

do their work at a reasonable rate. The ranges and averages of rates of performance and costs for cutting and chopping silage are given in Table 10. The information on corn binders is not very significant since only five machines are included in the analysis.

Loading and Hauling Bundles. An average of 9 men using 5 wagons with tractors or two trucks were used to load and haul bundles. With this size crew and this equipment an average of 8.6 tons per hour were hauled. The average rates of performance and costs for these operations are given in Tables 8 and 9.

Chopping Silage With Stationary Ensilage Cutter. To unload, cut, and elevate the silage an average crew of 3 men was used in addition to the operator of the truck or tractor. The average rate of unloading and elevating with this size crew was 8.6 tons per hour. In nearly all cases the cutter could handle the bundles faster than it could be cut with a corn binder if only one binder were used. In most cases a few loads were cut before the hauling crew started working.

Cutting and Chopping With a Field Harvester. Quite a few field harvesters are now being used in Missouri to cut and chop silage. Power take-off machines do satisfactory work except where crops are extra heavy and then the machines with engines are usually more satisfactory. The ranges and averages of rates of performance and costs for both kinds of field harvesters are given in Table 10. The relationship between annual use and cost per hour for field harvesters is shown in Figures 9 and 10. Some of the machines had attachments for both hay and row crops. In cases where the machine was used for both, the total annual use is simply the sum of the hours used with each attachment.

Hauling Silage. Where trucks were used to haul silage the average size of the hauling crew was 2 or 3 men. In most cases, two trucks were used and the average rate of hauling was 7 tons per hour. When wagons and tractors were used for hauling the average size of crew was 2 men. With 2 or 3

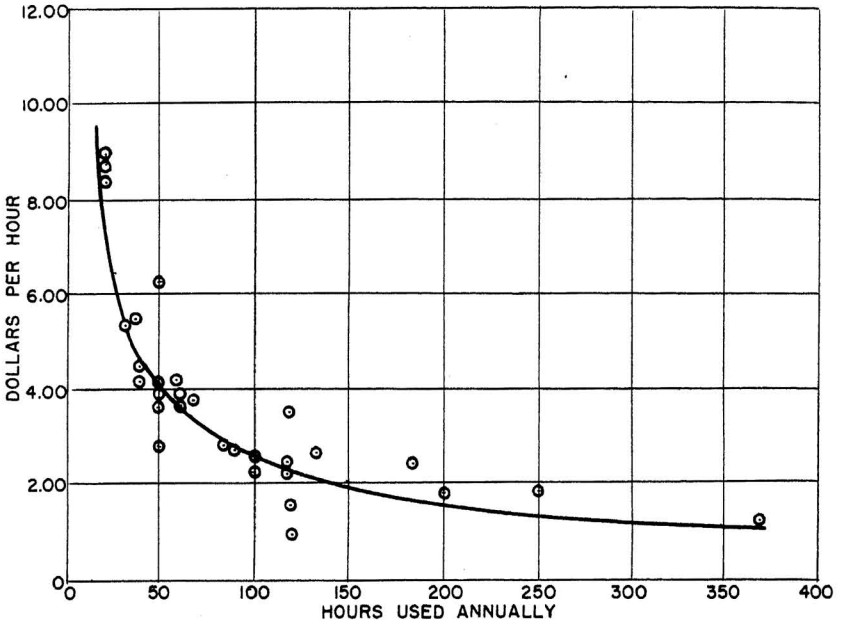

Figure 9.—Relationship between hours annual use and machine cost per hour for a field harvester without engine. Each circle represents one machine.

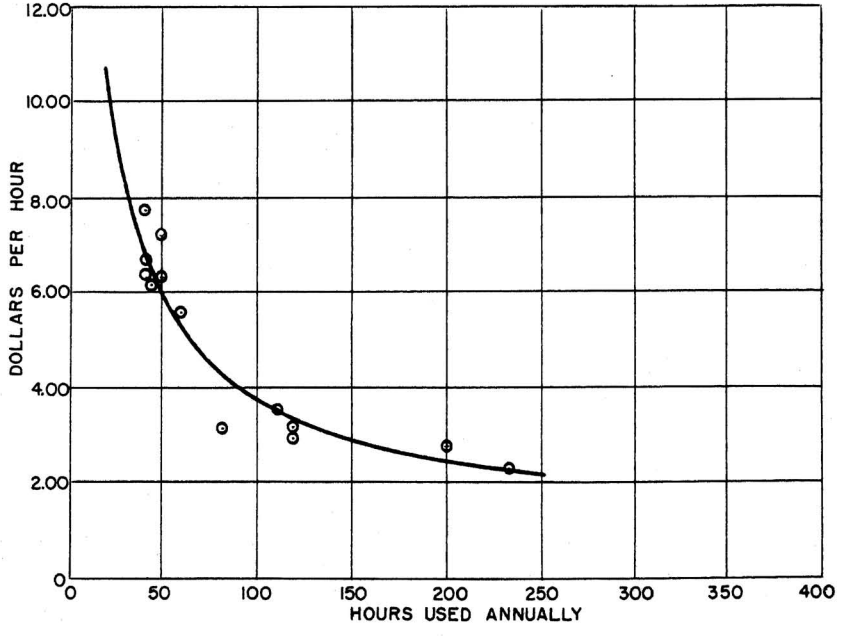

Figure 10.—Relationship between hours annual use and machine cost per hour for a field harvester with engine. Each circle represents one machine.

TABLE 11--RANGES AND AVERAGES OF RATES OF PERFORMANCE AND COSTS OF HAULING ENSILAGE

Machine	No. Using	Tons Per Hour			Cost Per Ton		
		Slow Third	Fast Third	Av. all Operators	High Cost Third	Low Cost Third	Av. all Operators
Wagons and tractors	14	4.9	8.2	6.4	$.48	$.27	$.38
Trucks	8	6.0	8.4	7.0	.89	.59	.76

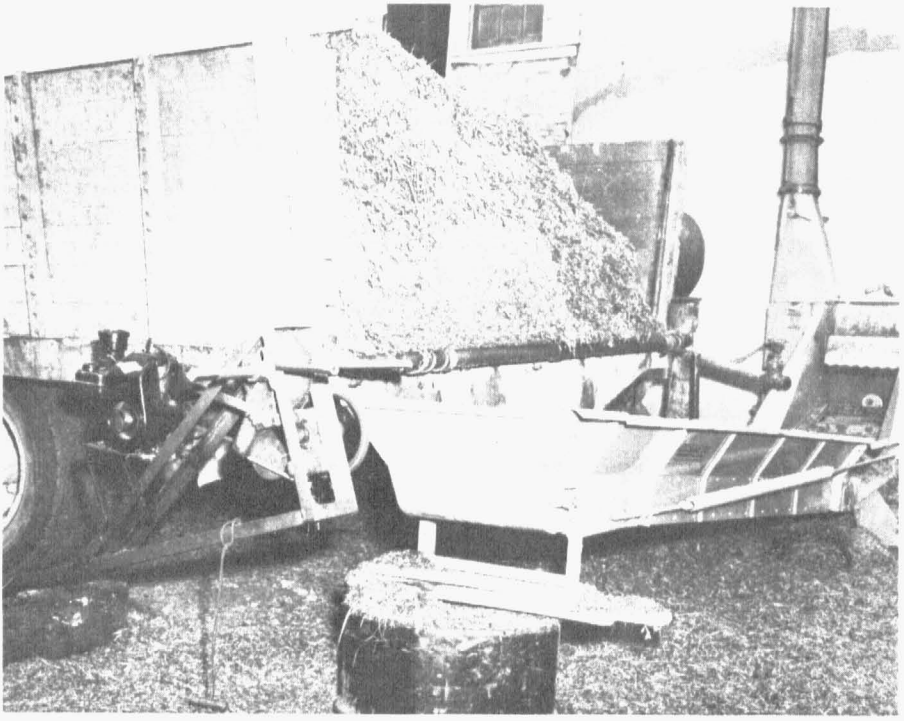

Figure 11.—An unloading device for use with either wagons or trucks. This 4-ton load of grass silage was unloaded in less than ten minutes.

wagons and 1 or 2 tractors, this crew could haul an average of 6.4 tons per hour. The ranges and averages of rates of performance and costs of hauling silage are given in Table 11.

Elevating Silage With Forage Blowers. An average of 2 to 3 men were used at the silo for unloading and elevating the silage in addition to the man operating the truck or tractor. The average rate of elevating was 6.7 tons per hour.

One factor which affected not only the rate of elevating but also the labor required was the method of unloading the silage from the wagons or trucks. Many farmers were unloading by pulling a false end gate through the wagon or truck bed with a tractor. Some were using a false end gate and a winch. Figure 11 shows one type of unloading device which is very satisfactory. The device can be quickly connected to a shaft mounted on the rear of the wagon or truck, and acts as a power driven winch to pull the false end gate. The shaft of the unloading device does not turn continuously, but is operated by a ratchet. It can therefore be turned very slowly and the silage can be unloaded more uniformly than when using a tractor to pull the false end gate. When a device of this type is used at least one less man is needed for unloading and the rate of unloading and elevating can be substantially increased.

CUSTOM WORK

With increasing machinery costs the farmer must consider carefully whether to buy all the machinery he uses or to hire custom operators to do part of his work. Some reasons for hiring custom machinery are as follows: (1) No capital is required for buying or financing machinery. (2) User is relieved of the responsibilities of ownership; does not stand the loss in case of breakdowns, poor seasons, etc. (3) It may actually be cheaper to hire a machine than to own and operate one if the machine is to be used only a few days per year. On the other hand machinery owners also have certain advantages. (1) The owner will always have his machine available for doing his own work when it needs to be done. Sometimes having a machine available will mean the difference between saving or losing a crop. (2) If the owner can use the machine a sufficient number of days per year, usually by doing some custom work for his neighbors in addition to his own work, his unit costs will be less than the rates of a custom operator.

Since many farmers do use their machinery to do custom work they should have a sound basis for establishing a fair custom charge. Unless for some reason his costs are abnormally high, the owner should receive a rental fee equal to the cost of using the machine on his own farm plus something in addition to compensate him for the responsibilities of ownership. Those who rent machines should be willing to pay such a cost.

Since the costs given in Table 1 include all the items which go to make up the fixed cost of a machine, they may be used as a basis for establishing rental rates. As an example, suppose that one farmer hires another to mow some hay using a 2-plow tractor and 7-foot tractor mower. The custom charge might be determined as follows:

	Cost per hour
Tractor, 2-plow	$0.28
Mower, 7 foot tractor	0.52
Fuel for tractor, 1.2 gal. @ $0.20	0.24
Oil and grease	0.04
Labor @ $0.75	0.75
Actual hourly cost	$1.83
Add 30% for responsibilities of ownership, time for moving equipment, etc.	0.55
Hourly custom rate	$2.38

If the charge is made by the acre then the custom rate per acre is simply the rate per hour divided by the acres per hour. If 2½ acres are cut per hour then the custom rate per acre would be $2.38 divided by 2½ or 95¢.

It must be borne in mind that the costs given in Table 1 as well as most of the other tables are average costs and therefore are not applicable to all machines. For example, the average machine cost for an automatic-tying, pick-up baler with engine is given in Table 1 as 76¢ per ton and the average total cost of baling with this type baler as $2.11 per ton in Table 6. The costs are based on an annual use of 700 tons per year and a labor cost of 75¢ per hour as well as average costs for fuel, oil, grease, twine, or wire. Suppose that an operator uses a baler of this type to bale only 350 tons per year. From Figure 6, it can be determined that the machine cost is likely to be about $1.25 per ton instead of 76¢. Assume further that labor cost is $1.25 per hour and that the rate of baling is 3½ tons per hour. The costs in this case might be approximately as follows:

	Cost per ton
Tractor	$0.10
Baler	1.25
Bale ties	0.80
Fuel for tractor and auxiliary engine assuming 3 gal. per hr. @ $0.20	0.17
Oil and grease	0.03
Labor @ $1.25 per hour	0.36
Actual cost per ton	$2.71
Add 50% for responsibilities of ownership, time for moving equipment, etc.	1.35
	$4.06

Thus some operators might easily be justified in charging $4.00 to $4.50 per ton for custom baling while others could make a good margin of profit by charging only $3.50 to $4.00 per ton.

APPENDIX

Some measures of the reliability of the cost curves presented in Figures 2 through 10 are shown in Table A. All of the curves are of the form $\text{Log } Y = a + b \text{ Log } X$ and were fitted by the method of least squares. Equations for the curves are given in Table B.

TABLE A--SOME MEASURES OF RELIABILITY FOR CURVES IN FIGURES 2 THROUGH 10

Machine	Number of Cases	Standard error of estimate in ratio form	Index of Correlation
2-plow tractor	21	0.82 to 1.22	0.92
7 ft. tractor mower	23	0.84 to 1.20	0.91
Side delivery rake on steel	14	0.77 to 1.30	0.92
Side delivery rake on rubber	20	0.77 to 1.30	0.89
Pick-up baler with engine, automatic tie	33	0.74 to 1.35	0.84
Pick-up baler without engine, automatic tie	24	0.71 to 1.41	0.66
Pick-up baler with engine, hand tie	16	0.76 to 1.31	0.91
Field harvester with engine	13	0.88 to 1.14	0.95
Field harvester without engine	30	0.79 to 1.26	0.90

Since the equations are of logarithmic form the standard error of estimate can best be expressed in terms of ratios. A standard error of estimate equal to 0.82 to 1.22 means that in 68 cases out of 100 the actual value will not be less than 82 per cent of the estimate nor more than 122 per cent of the estimate.

The index of correlation is an abstract measure of the degree of relationship between two variables. It depends upon the variability about the fitted curve in relation to the variability about the mean of the Y's. If the curve passed through every point, then the index or correlation would be 1.00. If there was no correlation between the curve used and the points, the index of correlation would be zero. The indexes of correlation as given in Table A range from a low of .66 to a high of .95, indicating in the main reasonably high reliability of the various cost curves.

TABLE B--EQUATIONS OF CURVES IN FIGURES 2 THROUGH 10

Machine	Units of Y	Units of X	Equation of Curve
2-plow tractor	Cents	10 Hour Days	Log Y = 2.988-0.788 Log X
7-ft. tractor mower	Cents	Hours	Log Y = 2.928-0.590 Log X
Side delivery rake on steel	Cents	Hours	Log Y = 2.952-0.616 Log X
Side delivery rake on rubber	Cents	Hours	Log Y = 3.182-0.661 Log X
Pick-up baler with engine, automatic tie	Cents	Tons	Log Y = 3.722-0.649 Log X
Pick-up baler without engine, automatic tie	Cents	Tons	Log Y = 3.100-0.513 Log X
Pick-up baler with engine, hand tie	Cents	Tons	Log Y = 3.880-0.783 Log X
Field harvester with engine	Cents	Hours	Log Y = 3.849-0.636 Log X
Field harvester without engine	Cents	Hours	Log Y = 3.697-0.639 Log X