COSTS AND LABOR USED TO HARVEST HAY BY DIFFERENT METHODS IN CORTLAND COUNTY, NEW YORK, 1945

A Preliminary Report to Cooperating Farmers

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by
Ellis W. Lamborn and L. B. Adkinson [1]

INTRODUCTION

One of the largest and most laborious jobs on New York farms is the harvesting of hay. In addition, this job must be accomplished in a relatively short period of time if high-quality roughage is to be obtained. Along with the problem of making high-quality hay, there are the problems of using available labor efficiently and of doing the job at minimum cost.

This preliminary report covers only the hauling and storing part of the haymaking operation. However, this is the part of haymaking which is most important, and in which there is the most room for improvement. A more complete report will be published later which will cover the cutting and field-curing operations and will supply more detail on the hauling and storing operations.

Areas and Farm Studied

Detailed information on the amount of labor and the cost of equipment used to harvest hay in 1945 were obtained by the survey method from 412 farmers. Ninety-seven of the farms studied were located in Cortland County, 64 in Washington County, and 251 farms in the four Western New York counties of Livingston, Wyoming, Genesee, and Ontario. This report is based on information obtained in Cortland County. Other reports will be available for the other areas and for the State.

Farms included in the study were selected to represent the important haymaking methods and kinds of hay, and the different sizes of farms. County Agricultural Agents and cooperating farmers helped provide information useful in making up the lists of farms to be visited. Insofar as possible about an equal number of farms using each of the major methods of harvesting hay was visited.

1/ The records were taken by the following: Ellis W. Lamborn, A. Neil McLeod, Roger G. Murphy, Dale A. Knight, and Frank P. King of Cornell University, and L.P. Gunsch and O.F. McGuire of the Bureau of Agricultural Economics, U. S. Department of Agriculture. L.P. Gunsch also assisted in the early stages of summarizing the records. Ivan R. Bierly assisted in the over-all planning of the project.

The farms selected for study are not a cross-section of haymaking methods on New York State farms 2/, but the farms using each of the common methods of harvesting hay are representative of the farms in the State using that method.

Method of Study

For each field from which hay was harvested on each farm, the following information was obtained.

(1) The number of hours to do each job; that is, mowing, raking, turning, tedding, baling, and hauling and storing.

(2) The number of persons in the crew for each job.

(3) The kind of power and the number of hours it was used.

(4) The kinds of other equipment used for each job and the number of hours of use.

The cost per hour of labor calculated for each farm was based on the total cost of labor used on the farm divided by the total hours of work done on the farm during the year. The average labor rates, therefore, include a high-than-average value attached to the operator's own labor because of his managerial responsibilities. They also include the lower-than-average value given to the labor of women and children. The cash wages and the operator's estimate of the value of farm perquisites given regular and seasonal hired workers are another component of the rates.

For each item of equipment used in making hay, except tractors and trucks, detailed information was obtained on the cost and hours of use (both for hay and other uses) for the year.

The amount of hay cut a second time varied between farms and between the different methods of harvesting hay. In order to make the data for different farms and different methods more nearly comparable, the first and second cutting of hay were enumerated and analyzed separately.

2/ Information on the percentage of the hay crop handled by various methods is contained in Brodell, A.P., Engebretson, T.O., and Carpenter, C. G., "Harvesting The Hay Crop", Bureau of Agricultural Economics, Washington, D. C., April 1946.

COMPOSITION AND SIZE OF THE LABOR FORCE

The labor force used in harvesting hay varied according to the individual circumstances on each farm. As the size of the hay enterprise increased, the average number of workers and the dependence on hired labor became greater, table 1. At the same time the proportion of women workers decreased. Most of the increase in the proportion of hired help on the larger farms arose from increased use of regular hired workers. The small operators more often could handle their hay crop with the help of youngsters, wives, and seasonal help than could those operating larger farms.

There was no typical crew organization for any of the methods used. Fewer hired workers were used with buckrakes than with other methods, table 2. This may have been due partly to the concentration of buckrakes on the smaller farms. Operators using buckrakes were also able to use a greater proportion of women workers. Baler operators and those using loaders and wagons had less help from women.

The smallest labor force reported on farms using the loader and wagon was one man in addition to the operator, reported by three farmers. Two loader and truck operators were able to harvest their hay with the help of one extra man and a boy each. One buckrake operator harvested his crop without help, one had the help of a daughter, three reported one boy each under 18 years old, and four received help only from their wives. Three operators of one-man balers had only one other man in their haying crews. Only two farmers using a three-man baler reported minimum crews of two extra men each. These data indicate that if the only help available is a boy or woman, a buckrake may be the most feasible method when other conditions are suitable.

Tables 1 and 2 show the labor force used other than the operator. They do not show the occasional use of youngsters or women on such odd jobs as mowing or raking for a few hours when other workers are busy. They should not be interpreted as showing the proportions of work done in haying by various members of the crew, because women and children often work only at the lighter jobs and during only a fraction of the time. However, on some jobs young boys and women can work as effectively as an able-bodied man.

TABLE 1 - COMPOSITION OF AVERAGE LABOR FORCE, OTHER THAN OPERATOR, IN HAY HARVESTING, BY SIZE OF HAY ENTERPRISE 1/

97 Farms, Cortland County, New York, 1945

Size of hay enterprise	No. of farms	Number of workers per farm	Percent of total number of workers								
			Family Labor				All family labor	Hired Labor			All male workers
			Male			Female					
			18 & over	Under 18	Total	Total		Regular	Seasonal	Total	
Small 2/	28	1.9	18	15	33	22	55	15	30	45	78
Medium 3/	34	2.4	11	15	26	18	44	24	32	56	82
Large 4/	35	3.8	22	6	28	8	36	38	26	64	92
All farms	97	2.8	18	10	28	14	42	29	29	58	86

1/ The numbers listed are the maximum number of workers available to help the operator in moving the hay from windrow to storage. All workers did not necessarily work during the entire job.

2/ Less than 70 tons. 3/ 70 - 120 tons. 4/ Over 120 tons.

TABLE 2 - COMPOSITION OF AVERAGE LABOR FORCE, OTHER THAN OPERATOR, IN HAY HARVESTING, BY METHOD OF HARVEST 1/

97 Farms, Cortland County, New York, 1945

Method of hay harvest	No. of farms	Number of workers per farm	Percent of total number of workers								
			Family Labor				All family labor	Hired Labor			All male workers
			Male			Female					
			18 & over	Under 18	Total	Total		Regular	Seasonal	Total	
Loader & wagon	24	2.9	12	10	22	7	29	41	30	71	93
Loader & truck	11	3.9	19	7	26	14	40	35	25	60	86
Auto buckrake	28	1.6	11	18	29	33	62	20	18	38	67
Tractor buckrake	7	2.3	19	12	31	31	62	6	32	38	69
One-man baler	9	2.6	31	4	35	9	44	30	26	56	91
Three-man baler	15	4.2	25	11	36	5	41	26	33	59	95
Other methods	3	3.0	22	---	22	11	33	11	56	67	89
All methods	97	2.8	18	11	29	14	43	29	28	57	86

1/ The numbers listed are the maximum number of workers available to help the operator in moving the hay from windrow to storage. All workers did not necessarily work during the entire job.

EQUIPMENT COSTS

Among the various kinds of equipment used in harvesting hay on the farms studied in Cortland County, the balers required the greatest investment, table 3. These figures were based on the owners' valuation under normal prices. Items used on the farms with large hay enterprises were usually valued high than were corresponding pieces of equipment on the farms with less hay. One reason for this was that, with the exception of comparatively new types of equipment such as pickup balers, the equipment on the larger farms was newer than that used on the smaller farms.

The total cost of operating machinery may be divided roughly into two portions - fixed and operating costs. The fixed costs such as those charged for interest, housing, and insurance are not greatly affected by the amount of work done. Operating costs such as repairs, fuel, twine and wire vary with the amount of work done with the machine. A machine depreciates in value whether it stands in the shed or is used in the field. Constant use increases the annual rate of depreciation somewhat, but diminishes the rate per hour of use.

The data on depreciation, repairs, gas, oil, electricity, twine, and wire in table 3 were also obtained from farmers' estimates. Interest was calculated at 5 percent on the owner's valuation of the machine. Housing costs were estimated from "Costs of Farm Power and Equipment," Cornell University Agricultural Experiment Station, Bulletin 751, by J.P. Hertel and Paul Williamson, supplemented by recent field studies. Insurance was calculated at $4.00 per $1,000 valuation.

Depreciation and interest are heavy cost items when an investment such as that made in balers is required, although they may not represent as high a proportion of the total cost of operation for balers as they do for less costly machinery. The total cost of operating pieces of haying equipment was usually greatest on farms with large hay enterprises. This arose not only from the fact that more work was done on these farms than on the smaller farms, resulting in greater operating and repair costs, but also from the heavier investment and consequently high depreciation and interest costs.

TABLE 3 - COST OF OPERATING EQUIPMENT USED IN HARVESTING HAY

97 Farms, Cortland County, New York, 1945

Item	Number of machines	Average inventory value	Depreciation	Repairs		Interest	Gas, oil, electricity	Twine and wire	Housing and other	Total cost
				Cash	Farm labor					
5' horse mowers	35	$ 38	$ 3.40	$ 5.74	$ 2.23	$ 1.90	—	—	$ 1.65	$14.92
6' horse mowers	17	48	4.65	4.85	1.85	2.42	—	—	1.69	15.46
Tractor mowers	61	95	11.93	5.52	1.83	4.77	—	—	1.38	25.43
Tedders	12	18	0.92	0.33	0.16	0.88	—	—	2.07	4.36
Dump rakes	11	17	2.82	0.14	—	0.86	—	—	1.56	5.38
Side-delivery rakes	88	74	8.78	3.57	1.19	3.72	—	—	3.80	21.06
Hay loaders	50	82	9.89	1.89	0.56	4.10	—	—	3.83	20.27
Auto buckrakes	31	176	15.61	10.19	2.03	8.81	$10.68	—	8.70	56.02
Tractor buckrakes	7	98	6.77	1.21	.29	4.93	—	—	3.39	16.59
Rubber-tired wagons	68	64	3.76	2.68	0.22	3.20	—	—	2.26	12.12
Steel-tired wagons	24	41	2.21	0.71	0.14	2.03	—	—	2.16	7.25
One-man balers	9	1652	346.00	119.72	24.67	82.62	43.10	$341.04	12.61	969.76
Three-man balers	15	726	83.33	37.00	14.00	36.29	27.47	186.80	8.90	393.79
Stationary balers	1	625	50.00	—	—	31.25	5.00	57.00	8.50	151.75
Blowers	1	125	—	—	—	6.25	—	—	4.50	10.75
Stationary choppers	1	250	20.00	16.00	1.00	12.50	—	—	5.00	54.50
Hay forks, ropes, etc.	81	75	3.66	4.15	0.19	3.74	—	—	.30	12.04
Hay hoists	12	54	2.75	0.58	0.08	2.71	1.10	—	.72	7.94
Bale elevators in barn	8	95	5.25	—	—	4.75	1.43	—	1.88	13.31
Bale elevators in field	2	191	18.00	—	—	9.55	2.45	—	4.26	34.26

In comparing the tractor buckrake costs with those for auto buckrakes in table 4, the reader should remember that the auto buckrake figures include power, while the expense of tractor operation is not included in the tractor-buckrake cost.

With a few exceptions, haymaking equipment was also used for other purposes, table 4. This had the effect of spreading fixed costs over a wider base and reducing costs per unit of work done. This effect is illustrated by the fact that although valuation and the total cost of operation were usually greatest on the largest farms, only in the case of auto buckrakes and one-man balers were the costs per ton of hay highest on the large farms. In the case of one-man balers, on the large farms 39 percent of the total use was on the owner's hay and the balers were actually used less than were those on the smallest farms where only 6 percent of all use was on the owner's hay.

A comparison of these data with information obtained from a less extensive study in Cortland County for 1944 indicates that there was little difference in the costs of operating hay harvesting equipment between the two years. The most outstanding difference in equipment use was that, on the farms studied in 1944, three-man balers were used 61 percent of the total time on the owner's hay and in 1945 the percentage was down to 39. This, together with a similar, but smaller, change in the use of one-man balers, indicated a greater demand for custom baling service in 1945 than in 1944. An estimate of hay baled away from home was obtained from the farmers, but this information has not yet been compiled.

MOVING HAY FROM WINDROW TO STORAGE

About two-thirds of the total expense and labor in harvesting hay is spent in moving the hay from the windrow to storage. The variations in method for this part of the harvest are greater than they are for the operations in cutting and curing. This report does not include a discussion of cutting and curing.

The general methods of handling hay after it is cured are by use of loaders, buckrakes, balers and by hand. Certain details concerning each general method may vary greatly from farm to farm. For example, loaders may be used with trucks or with horse or tractor-drawn wagons. Unloading at the barn may be by a rope and fork or sling, pitched into a stationary blower or chopper, or pitched into the mow by hand.

TABLE 4.- COST, PER UNIT HARVESTED, OF USING EQUIPMENT IN HARVESTING HAY, 1/

97 Farms, Cortland County, New York, 1945

Item	Total cost of operating	Total hours of use	Cost per hour	Variation in average hourly cost		Percentage of use of own hay	Unit costs on hay		
				High one-third	Low one-third		Unit	Total units handled	Ave. cost per unit
5' horse mowers	$ 14.92	48	$0.31	$0.60	$0.15	86	acre	36	$0.36
6' horse mowers	15.46	60	0.26	0.73	0.12	90	acre	49	0.29
Tractor mowers	25.43	58	0.44	1.07	0.20	79	acre	61	0.33
Tedders	4.36	10	0.43	1.96	0.16	83	acre	19	0.19
Dump rakes	5.38	11	0.47	1.49	0.19	95	acre	26	0.20
Side-delivery rakes	21.06	52	0.40	0.97	0.19	88	acre	84	0.22
Hay loaders	20.27	77	0.26	0.67	0.10	92	ton	94	0.20
Auto buckrakes	56.02	71	0.79	1.38	0.41	67	ton	67	0.56
Tractor buckrakes	16.59	58	0.29	0.67	0.14	91	ton	63	0.24
Rubber-tired wagons	12.12	190	0.06	0.14	0.03	38	ton	70	0.07
Steel-tired wagons	7.25	121	0.05	0.12	0.03	42	ton	41	0.07
One-man balers	969.76	211	4.59	9.76	2.97	25	ton	110	2.20
Three-man balers	393.79	152	2.59	4.89	1.63	39	ton	159	0.97
Stationary balers	151.75	16	9.48	--	--	100	ton	21	7.23
Blowers	10.75	40	0.27	--	--	95	ton	100	0.10
Stationary choppers	54.50	68	0.80	--	--	71	ton	70	0.55
Hay forks	12.04	69	0.18	0.38	0.07	100	ton	89	0.14
Hay hoists	7.94	55	0.14	0.54	0.03	100	ton	109	0.07
Bale elevators at barn	13.31	36	0.37	1.12	0.19	71	ton	165	0.06
Bale elevators in field	34.26	121	0.28	--	--	59	ton	198	0.10

1/ These costs do not include the labor used in operating the machine. They include power costs only when the power is a part of the machine.

In the following discussion and tables, information on factors associated with various methods is presented. The analysis is on a field rather than a farm basis. In these tables, averages are usually weighed by the tonnage or acreage handled, and therefore reflect the influence of the larger farms.

For some methods there were not enough fields to establish reliable averages. In general, little significance should be attached to any data which is based on less than 20 observations. The data are presented in this report because it will be of interest to those farmers who supplied the information.

Factors That May Influence the Choice of Method

The farmers using balers handled larger-than-average tonnages of hay. Farms where buckrakes or loaders and wagons were used handled less-than-average tonnages of hay.

Balers were used on larger fields than were other methods, table 5. Hand loading was used on smaller fields than was any other method. The differences between the other methods in the average size of field were small.

No definite pattern appeared in the yields on the first cutting from fields on which different methods were used. The yield from fields harvested by hand was low, but there were too few cases for the difference to be significant. Where the physical characteristics were such that machinery could not well be used, yields, too, would probably suffer.

The distance from the field to the barn is an important factor in deciding which method to use. The distance of haul where buckrakes were used averaged less than a quarter of a mile, except where a buckrake hauled to a stationary baler. In this case the distance does not apply to the distance the buckrake hauled the hay, but rather to the length of haul after it was baled. The longest average haul occurred where hired balers were employed. Apparently many farmers hired a baler for the fields that were farthest from the barn, reasoning that by making fewer trips with heavier loads of baled hay they could offset much of the extra cost of baling.

TABLE 5 - PHYSICAL FACTORS ASSOCIATED WITH VARIOUS METHODS OF HANDLING FIRST-CUTTING HAY

97 Farms, Cortland County, New York, 1945

Method	Number of fields	Average size of field (acres)	Average yield per acre (tons)	Distance from field to barn (miles)	Ave. no. in crew	
					Baling	Hauling & storing
Loader:						
and wagon	146	8.2	2.2	.40	--	3.4
and truck	66	7.4	2.3	.45	--	3.8
truck and wagon	39	7.0	2.1	.43	--	5.6
and chopper	3	10.7	2.2	.23	--	2.7
Buckrake:						
auto	115	7.2	2.1	.23	--	2.8
tractor	29	6.7	2.0	.17	--	3.1
auto and blower	4	8.8	3.0	.18	--	2.0
Baler:						
hired	22	13.8	1.9	.96	2.2	3.1
owned:						
1-man	40	11.8	2.1	.38	1.4	3.7
3-man	86	11.0	2.4	.32	3.0	2.9
buckrake to stationary	9	5.6	1.9	.49	4.7	2.1
Pitched on by hand	8	1.8	1.7	.20	--	3.4

The number of workers required is a factor of importance to the farmer who is considering which method he shall use. The figures in table 5 on the average number in the crew, differ from those in table 2, in that the numbers in table 2 represent the maximum number of individuals working on each farm in addition to the operator during some portion of hay harvest, while table 5 shows the average number including the operator. There was a wide range in the numbers employed on different farms where the same methods were used. The average number of workers used with buckrakes was lower than that for most of the other methods. If baling, hauling and storing were done simultaneously, more workers would be needed than would normally be used if the hay were handled in some other way. However, if the number of workers is limited,

hay can be baled; then the same crew can shift to hauling and storing. Hay can be put in the barn less rapidly this way than if two crews are used, but the size of the crew needed is reduced. Usually hay can be put in the mow as fast as it can be hauled when two crews are available, as hauling and storing is slower than baling on most farms.

Rate of Performance

The time required to move cured hay from the windrow to storage is a critical factor because each hour of delay increases the probability of rain damage and the amount of sun bleaching.

Ordinarily, a farmer will not cut more hay than can be hauled to the barn in an afternoon. Thus, the acreage cut at one time bears some relation to the over-all speed of handling hay. Exceptions occur when hay is baled and left in the field overnight. The relationship between acreage cut and the time required for storage is altered also when hay is hauled to the barn in the evening, but not put in the mow until the next morning. Larger acreages were cut at one time when balers were used than when either loaders or buckrakes were employed, table 6.

There are two distinct operations in handling baled hay: the actual baling, and hauling and storing the bales. The figures in table 6 show that baled hay could be hauled and stored faster than could loose hay. However, the additional time needed for baling was sufficiently great to more than offset this advantage, and the total hours per ton for baled hay were a little greater than for most other methods except hand loading. If two crews were available so hauling could be done at the same time as baling, hay could be baled and put under cover faster than by the other methods.

Baled hay was hauled and stored at approximately the same speed as the baling was done when either one-man or three-man balers were used on the home farm. When they were hired, baling was considerably faster than hauling to storage. Probably this was due partly to the experience of the custom baler operators and partly to the relatively long distance hay was hauled from these fields.

The difference between the auto and tractor buckrakes in the quantity of hay hauled per hour was partly due to the difference in length of haul. The rates for loader, wagon, and chopper, for auto buckrake and blower, and for buckrake to stationary baler, may not be representative, as each was used on fewer than 10 fields.

TABLE 6 - RATES OF PERFORMANCE IN BALING, HAULING AND STORING FIRST-CUTTING HAY BY VARIOUS METHODS

97 Farms, Cortland County, New York, 1945

Method	No. of fields	Area cut at one time (acres)	Tons per hour of operation		Total hours of operation per ton		
			Baling	Hauling and storing	Baling	Hauling and storing	Total
Loader:							
and wagon	146	4.3	--	1.3	--	0.8	0.8
and truck	66	4.0	--	1.3	--	0.8	0.8
truck and wagon	39	6.5	--	1.9	--	0.5	0.5
wagon and chopper	3	10.7	--	1.5	--	0.7	0.7
Buckrake:							
auto	115	3.4	--	1.2	--	0.8	0.8
tractor	29	4.4	--	1.7	--	0.6	0.6
auto and blower	4	5.0	--	2.6	--	0.4	0.4
Baler:							
hired	22	7.0	2.8	2.0	0.4	0.5	0.9
owned:							
1-man	40	7.5	2.1	2.1	0.5	0.5	1.0
3-man	86	6.5	2.7	2.4	0.4	0.4	0.8
buckrake to stationary	9	4.2	1.7	2.7	0.6	0.4	1.0
Pitched on by hand	8	1.6	--	0.9	--	1.1	1.1

The experience that the operator has had with the method in use has some bearing on his rate of performance. Operators using the loader and wagon and the hand methods had used these methods for over 15 years on the average. The averages for buckrake and baler operators were less than 3 years. Three-man baler operators averaged 2.7 years of using the method as compared with 1.3 years for the one-man baler operators.

Labor Used And Its Cost

Slightly less labor per ton of hay handled was needed when buckrakes were used than was the case if balers were employed, table 7. More man hours per ton were used with loaders than with either buckrakes or balers. The data for hired balers show only labor furnished by the farmer; that supplied by the custom operator would increase the total considerably. About 0.8 man hour of labor per ton was furnished by the custom operator; the cost of this labor is included in the custom charge in Table 8.

Differences between methods in the hourly cost of labor arise from three principal sources: (1) The rates for the operator and unpaid family labor were based on estimates by the operators. (2) The type of labor required to operate different haymaking machines may vary. The proportion of women and younger family workers was higher when buckrakes were used, than it was with some other methods. The labor of these less physically strong workers was valued at a lower rate than was the work performed by an adult male. (3) There was a variation both in the methods used and in the composition of the labor force between farms with different-sized hay enterprises.

The labor costs for buckrakes, both tractor and auto, were below those of any of the other common methods, except hired balers. Labor cost for loaders, except for loaders and choppers, were higher than they were for either buckrakes or balers.

Cost of Power and Equipment

The costs of power and equipment when balers were used were higher than with other methods, table 8. The principal reason was the high investment in the balers and the heavy fixed expenses resulting therefrom. Power and equipment costs for one-man balers were higher than for three-man outfits. The valuation of the one-man machines averaged more than twice that for three-man balers, table 3. Not only were they much newer, but their original purchase price was more than that of the three-man balers. They were also operated more slowly. All of these factors were sufficient to outweigh the advantage they gained from being used a greater number of hours than were the three-man balers.

Power and equipment costs varied little as between buckrakes and loaders. The costs of both were well below those for balers, even though the average tonnage handled by buckrake or by loader and wagon was lower than for balers.

TABLE 7 - AMOUNT AND COST OF LABOR[1] USED IN MOVING FIRST-CUTTING HAY FROM WINDROW TO STORAGE BY VARIOUS METHODS,

97 Farms, Cortland County, New York, 1945

Method	No. of fields	Man hours per ton			Cost per hour of labor	Labor cost per ton[2]		
		Baling	Hauling and storing	Total		Baling	Hauling and storing	Total
Loader:								
and wagon	146	--	2.6	2.6	$0.51	--	$1.33	$1.33
and truck	66	--	2.8	2.8	0.53	--	1.41	1.41
truck and wagon	39	--	3.0	3.0	0.52	--	1.55	1.55
and chopper	3	--	1.8	1.8	0.45	--	0.80	0.80
Buckrake:								
auto	115	--	2.3	2.3	0.51	--	1.17	1.17
tractor	29	--	1.6	1.6	0.45	--	0.79	0.79
auto and blower	4	--	0.8	0.8	0.41	--	0.30	0.30
Baler:								
hired	22	0.1	1.6	1.7	0.60	$0.09	0.92	1.01
owned:								
1-man	40	0.7	1.8	2.5	0.52	0.34	0.85	1.19
3-man	86	1.1	1.2	2.3	0.54	0.63	0.65	1.28
buckrake to stationary	9	2.7	0.9	3.6	0.50	1.29	0.53	1.82
Pitched on by hand	8	--	4.0	4.0	0.43	--	1.80	1.80

1/ The labor furnished by the operator of a hired baler, about 0.8 man hours per ton, is not included.

2/ The man hours per ton multiplied by the cost per hour may differ slightly from the labor cost per ton, because the man hours per ton is a weighted average of the total labor cost divided by the total tonnage harvested by each method. The cost per hour is a simple average of the rates on each farm using the method.

TABLE 8 - COST OF POWER AND EQUIPMENT PER TON OF FIRST-CUTTING HAY HARVESTED BY VARIOUS METHODS

97 Farms, Cortland County, New York, 1945

Method	No. of fields	Cost per ton, for equipment and power:			
		Hired baler	Owned power & equipment: Used in field	Owned power & equipment: Used at barn	Total
Loader:					
and wagon	146	--	$0.72	$0.40	$1.12
and truck	66	--	0.49	0.27	0.76
truck and wagon	39	--	0.64	0.29	0.93
and chopper	3	--	0.47	0.72	1.19
Buckrake:					
auto	115	--	0.61	0.41	1.02
tractor	29	--	0.47	0.28	0.75
auto and blower	4	--	0.32	0.29	0.61
Baler:					
hired	22	$3.62	0.32	0.02	3.96
owned:					
1-man	40	--	3.28	0.02	3.30
3-man	86	--	1.47	0.04	1.51
buckrake to stationary	9	--	3.51	--	3.51
Pitched on by hand	8	--	0.71	0.80	1.51

The cost for power and equipment used at the barn for hay baled by any method was very low because many farmers unloaded their baled hay by hand.

The explanation for the high cost of equipment and power in the case of loading by hand is two fold. The rate of performance was so low that equipment and power were in use a long time per ton. The tonnage handled by this method was so low that fixed costs remained high.

All Costs; First Cutting

It should be remembered that the total costs per ton presented in table 9 are applicable only to 1945. Costs will vary from year to year depending upon wage rates, yields, and weather, and, to some degree, upon changes in the costs of power and machinery.

The costs within most methods showed more variation than did average costs between methods. A highly efficient operator using nearly any method will have lower costs than will a less efficient operator using some other method.

In general, buckrake costs, especially for tractor buckrakes, were slightly lower than loader costs, and well below those for balers. It was more expensive to hire baling done than to do it with one's own equipment. On the other hand, the average farmer who hired a baler, unless he could do additional baling, could not have bought and maintained a baler of his own as cheaply as he could hire the work done. Had there been more cases where a buckrake and blower or a loader and chopper were used, more definite conclusions as to their economy might be justified.

Second Cutting

All of the farmers did not make a second cutting of hay. Many of those who did, cut only one or two fields. As a result, many of the data may lack significance.

A summary of the cost necessary to move second-cutting hay from the windrow to the mow is presented in table 10. In general, it cost slightly more to haul and store a ton of second-cutting hay than it did to haul and store a ton of first-cutting hay. The largest differences in the costs for the two cuttings were on the truck and wagon, the one-man balers, and on hay loaded by hand. There were too few cases where the hay was cut a second time by these methods to permit significance to be attached to these differences.

Differences in costs of handling the first and second cuttings of hay did not affect the over-all cost per ton very much. Only about 8 percent of the total crop in Cortland County was obtained on the second cutting. Therefore, costs of the first cutting approximated the average for both cuttings.

TABLE 9 - TOTAL COST PER TON TO MOVE FIRST-CUTTING HAY FROM WINDROW TO STORAGE BY VARIOUS METHODS,

97 Farms, Cortland County, New York, 1945

Method	No. of fields	Cost per ton			
		Hired baling	Labor	Power and equipment	Total
Loader:					
and wagon	146	--	$1.33	$1.12	$2.45
and truck	66	--	1.41	0.76	2.17
truck and wagon	39	--	1.55	0.93	2.48
and chopper	3	--	0.80	1.19	1.99
Buckrake:					
auto	115	--	1.17	1.02	2.19
tractor	29	--	0.79	0.75	1.54
auto and blower	4	--	0.31	0.62	0.93
Baler:					
hired	22	$3.62	1.01	0.34	4.97
owned:					
1-man	40	--	1.19	3.30	4.49
3-man	86	--	1.28	1.51	2.79
buckrake to stationary	9	--	1.82	3.51	5.33
Pitched on by hand	8	--	1.80	1.51	3.31

TABLE 10 - TOTAL COST PER TON TO MOVE SECOND-CUTTING HAY FROM THE WINDROW TO THE MOW BY VARIOUS METHODS

97 Farms, Cortland County, New York, 1945

Method	No. of fields	Cost per ton			
		Hired baling	Labor	Power and equipment	Total
Loader:					
and wagon	31	--	$1.43	$1.28	$2.71
and truck	21	--	1.29	1.02	2.31
truck and wagon	1	--	0.67	0.66	1.33
Buckrake:					
auto	19	--	1.33	1.05	2.38
tractor	4	--	1.08	0.77	1.85
Baler:					
hired	5	$3.69	1.02	0.19	4.90
owned:					
1-man	5	--	0.96	2.34	3.30
3-man	16	--	1.29	1.83	3.12
buckrake to stationary	1	--	2.03	2.97	5.00
Pitched on by hand	3	--	0.70	0.51	1.21

RAIN DAMAGE

Unusually wet weather throughout most of the summer of 1945 was a severe handicap to hay harvesting. It caused heavy spoilage and a higher than normal damage not only by wetting hay in the swathe, windrow, or bale, but also on many farms in delaying harvest past the time when best quality hay could be cut. In addition, more than usual tedding and turning of hay was required, and the cost of harvesting was increased.

For these reasons the percentage of rain damage, based on farmers' estimates by fields of the tonnage of hay that was damaged, shown in table 11, cannot be taken as representative of normal conditions. In other years the relative proportions of damaged hay in the various methods used may change radically. There were too few cases, especially in the second cutting, for some methods to establish reliable averages.

The greatest difference shown by the table is that between cuttings. Over one-third of the first cutting of hay on the farms studied was damaged, but only about one-seventh of the second-cutting was rained on. Only 4 of the 97 farmers reported that none of their hay from the first cutting was damaged, whereas a majority escaped damage to the second cutting. Part of the reason for this difference was due to more favorable weather at the time of the second cutting. The lighter yield in the second cutting may also have required less time to cure in the field.

The differences in the percentages of damage with different methods probably are not significant. It is probable, too, that the figures only approximate the actual damage under different methods. In some cases the farmer, after damage had occurred, probably shifted to some other method than the one he had originally planned to use.

A similar study on 38 farms in Cortland County for the 1944 season showed rain damage on 16 percent of the first cutting of hay. Perhaps not only fewer tons of hay were damaged in 1944, but they may have been damaged less severely than in 1945. The percentage damaged in 1944 was lowest on farms using buckrakes and highest on those using balers, but the difference was small.

TABLE 11 - PERCENTAGE OF HAY HARVESTED BY VARIOUS METHODS AND BY CUTTINGS THAT WAS DAMAGED BY RAIN

97 Farms, Cortland County, New York, 1945

Method Used	Cutting				
	First		Second		Both
	No. of farms	Percent damaged	No. of farms	Percent damaged	Percent damaged
Loader and wagon	38	34	20	13	32
Loader and truck	16	27	8	12	26
Auto buckrake	30	41	12	9	39
Tractor buckrake	7	38	2	20	37
One-man baler	9	35	3	0	34
Three-man baler	15	46	9	18	44
Custom baler	12	22	3	39	24
Other methods	14	32	3	20	30
All	97 1/	36	54 1/	14	35

1/ Because more than one method was employed on some farms, the number of farms does not total to 97, and 54 on first and second cutting respectively.

OPERATORS' EVALUATION OF THEIR METHODS

Each farmer was asked during the interview the advantages and disadvantages of his method of harvesting hay in comparison with other methods. The replies are summarized in table 12.

One-third of the loader and wagon operators mentioned the low investment needed with their method. The only disadvantage which they specifically mentioned was inefficient use of labor. However, one-fourth were planning to change to pick-up balers.

TABLE 12 - OPERATORS' STATEMENTS OF ADVANTAGES AND DISADVANTAGES OF THEIR METHODS OF HARVESTING HAY AND THEIR INTENDED CHANGES IN METHOD

97 Farms, Cortland County, New York, 1945

Advantage, disadvantage, and change planned	Farmers using each method who mention specified advantages, disadvantages, and changes planned					
	Percentage of 24 using loader & wagon	Percentage of 11 using loader & truck	Percentage of 28 using auto buckrake	Percentage of 7 using tractor buckrake	Percentage of 9 using one-man baler	Percentage of 15 using three-man baler
Advantages						
"Saves labor"	25	36	86	71	56	47
"Can use family labor"	21	18	25	43	22	20
"Work is easier"	--	9	39	43	22	33
"Low investment"	33	27	57	57	11	7
"Low cash expense"	--	9	11	14	--	7
"Better suited to farm topography"	4	18	11	--	11	7
"Better suited to farm's hauling distance and access to storage"	--	55	25	14	11	7
"Easier to feed"	12	--	18	--	67	53
Disadvantages						
"Wastes labor"	17	--	4	--	--	7
"Poorly suited to farm topography"	--	--	--	--	11	--
Plan a change to:						
Loader	--	--	7	--	--	--
Buckrake	--	18	--	--	--	--
Pickup baler	25	18	11	--	--	7
Total planning change	25	36	18	--	--	7

Over half of the users of loaders and trucks believed that this method had an advantage due to the distance of haul or accessibility of storage on their farm. No disadvantages were cited, but over one-third were planning to change either to buckrakes or pick-up balers.

All but 6 of the 35 buckrake operators mentioned a saving in labor as an advantage of this method. Fifty-seven percent of the users of both auto and tractor buckrakes pointed out the low investment required. About 40 percent of the operators of both kinds of buckrakes said that this method made work easier. One auto buckrake operator believed the buckrake required too much labor. None of the tractor buckrake operators planned a change in method, but two farmers using auto buckrakes expected to change to loaders and three to pick-up balers.

A majority of the pick-up baler operators desired baled hay for feeding. The next most frequently mentioned advantage was a saving in labor. One farmer believed that his baler was poorly suited to the farm topography, and one-three-man baler operator said that too much labor was required. None of the farmers using one-man balers planned to change methods. One of the operators of three-man balers expected to shift to a one-man outfit.

If these changes are effected, twelve of the 97 farmers will change to pick-up balers, but only 4 will adopt other methods. If this shift is representative of general conditions, many more farmers will soon have balers, there may be less custom baling remaining to be done, and competition among owners of pick-up balers for custom jobs is likely to be more intense.

CONCLUSIONS

The data obtained in this study show that in 1945 the total cost of moving a ton of hay from windrow to storage by the methods most commonly used in Cortland County varied from about $1.50 when tractor buckrakes were used, to nearly $5.00 when a baler was hired. Features peculiar to the individual farm may offset any advantage or disadvantage arising from the comparative costs of the different methods.

Because there is no one way to harvest hay that is best for all farms, perhaps the following conclusions based on analysis of the statistical data obtained in the study, the farmers' appraisal of their methods, and the impressions gained by the interviewers in their contacts with the farmers, may be of assistance to farmers who are considering which method to use.

The loader and wagon method is adapted to moderate hauling distances and to considerable use of family labor. Greater speed on the longer hauls may be obtained if a truck is substituted for the wagon. The investment is low, but considerable hard work is required both in loading and in the mow. The cost of putting up hay by this method is likely to be less than if a baler is used, but there is often much work required to untangle the hay preparatory to feeding. A loader and truck or wagon is the most commonly used method and may be used under widely varying conditions.

If the barn is strongly built and if mow space is limited, the hay may be run through an ensilage cutter and the chopped hay blown into the barn. This method may require special carts or barn arrangements if feeding is to be efficient.

The buckrake is best adapted to those farms where most of the fields are relatively close to the barn and are accessible by means of wide, smooth lanes. If a car buckrake is to be used, it should be built on a truck or heavy automobile chassis in order to support a sufficiently large load for efficient operation. The lifting mechanism should be powerful and speedy in action, else too much time will be lost in raising the load. Best results can be secured at the barn with a sling, grapple fork, or blower; the hay is too loose to use the harpoon type fork successfully. If a tractor buckrake is used, it might be preferable to have a type that is readily demountable so that the tractor could be used for other jobs in the mornings. Some buckrakes built for tractor operation are so small that only rather small loads can be hauled. Either type of buckrake is better adapted to a farm where the labor force is small, than are most of the other methods studied.

The cost of putting up hay with a baler is greater than with most of the other methods, but over half of the farmers using balers stressed the ease in feeding baled as compared with loose hay. Perhaps the saving in time required for feeding baled hay would offset a part of the extra cost in handling and storing hay in this way, but no figures were obtained on this point. When mow space is limited, a greater tonnage of baled hay can be stored than loose hay. The baler has an advantage in the case of a long haul because heavy loads can be put on a truck without the danger of jostling off part of the load. If a farmer is able to put a crew on the baler and another at hauling and storing bales, he may be able to concentrate his hay harvest into a shorter period of time than if some other method is used.