

A Study of the Newer Hay-Harvesting Methods
on Ohio Farms

F. L. Morison

Department of Rural Economics and Rural Sociology
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A STUDY OF THE NEWER HAY-HARVESTING METHODS ON OHIO FARMS

Tractor-drawn tillage implements, combines, and mechanical corn pickers have greatly decreased the total amount of labor spent in caring for corn and small grain crops in Ohio in the past twenty years. Tractor cultivators and combines have done much to reduce the labor peak, once so common in Ohio in June and early July. In recent years, increased emphasis has been placed on forage crops as a means of checking erosion and maintaining productivity of the soil. From 1930 to 1940 the acreage of alfalfa hay in Ohio almost trebled. Yet today on many otherwise modernly equipped farms the type of hay-harvesting equipment in use is the same as that used 25 years ago.

Only recently have new hay-harvesting machines begun to make their appearance in Ohio. These changes in hay-harvesting methods are coming about in part because of necessity. As labor shortages become more acute, it is to be expected that labor-saving practices will be more generally adopted. Changes in hay-harvesting methods have also been stimulated by a growing appreciation of the value of high quality roughage. More speed is needed to get as much hay as possible into storage each day available for making hay. Delays beyond the optimum date for making hay result in lower quality. Sometimes delays in harvesting alfalfa are such that only two cuttings can be made instead of three. Then both quality and total yield of hay are reduced.

Purpose of Study

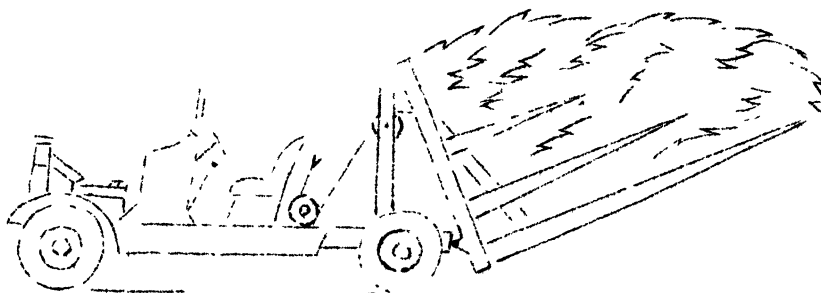
This study was made for the purpose of securing information on the machinery investments, labor requirements, and total costs of putting up hay by the various new methods, and the advantages and disadvantages of each.

Method of Study

Three areas were selected for study, all in northern Ohio. The first area covered Van Wert County; the second included most of Hardin County plus parts of Putnam, Hancock and Allen counties centering around the village of Bluffton; and the third was an area in east-north-central Ohio, extending from Huron and Medina counties on the north to Knox and Holmes on the south.

The field study was made during the month of August 1941. Only those farmers known to have buck rakes, ^{1/} pick-up balers or hay choppers were contacted. The names of a few of these men were first secured from county agents, implement dealers, and makers of buck rakes. Records were obtained from these farmers, who in turn supplied names of neighbors using one of the newer haying methods. The sample obtained in this way, while not complete, was thought to be representative. Records were secured from 167 farms, 57 in Van Wert County, 80 in the Hardin-Bluffton area, and 30 in the east-north-central part of Ohio.

^{1/} Side-view sketch of an automobile buck rake, loaded by driving in reverse. Tractor rakes are usually mounted in front. A lifting mechanism raises or lowers the rake which is hinged at the base. When a rake load of hay has



been taken up from the windrow, the ends of the teeth are lifted and the load transported to the barn. To unload, the rake is lowered again and pulled away from beneath the load.

The operators who had adopted the use of buck rakes, pick-up balers and hay choppers had farms averaging 212 acres in size, compared with 103 acres the average size of all farms in the 13 counties where the study was made. The relative importance of the different method or methods in use on these 167 farms is shown in table 1.

Table 1.- Number of farms, average size of farm and tons of hay made per farm employing different hay-harvesting methods, 1941

Method or methods used	farms studied	Average size of farm	Hay made* per farm, 1941
	Number	Acres	Tons
Buck rake	118	187	40
Buck rake and loader	12	268	48
Pick-up baler	9	233	47
Pick-up baler and loader	3	216	65
Hay chopper	6	304	85
Pick-up baler and buck rake	4	260	71
Hay chopper and buck rake	3	312	103
Other combinations	7	314	73
Total	167	212	47

* Excludes custom work off the farm.

Starting with an average of 40 tons of hay harvested with a buck rake as a standard, it is observed that farms with larger amounts of hay used either a combination of methods or a method that was more mechanized.

Further classification of these 167 farms according to hay-harvesting method gives a total of 199 records (table 2).

Table 2.- Distribution of records obtained, by method, 167 Ohio farms, 1941

Methods used	Number of farms	Total	Number of records, by method					
			auto buck rake	Tractor buck rake	Pick-up baler	Station-ary cropper	Field cropper	Hay loader
Buck rake	118	118	74	44	-	-	-	-
Buck rake & loader	12	24	6	6	-	-	-	12
Pick-up baler	9	9	-	-	9	-	-	-
Pick-up baler and loader	3	16	-	-	8	-	-	8
Hay chopper	6	6	-	-	-	4	2	-
Pick-up baler and buck rake	4	8	2	2	4	-	-	-
Hay chopper and buck rake	3	6	2	1	-	3	-	-
Other combinations	7	12	-	-	2	3	1	6
Total	167	199	84*	53	23	10	3	26

* Of this total, 66 buck rakes were mounted on old automobiles, 18 on trucks. No distinction is made here between these two types, all being referred to in this publication as "auto buck rakes."

It will be noted that buck rakes were by far the most common hay-harvesting method found on these farms. One-half of the operators used auto buck rakes and nearly one-third had buck rakes mounted on tractors. Pick-up balers and hay choppers, involving larger investments in equipment, were in the minority. Records on hay loaders obtained in this study covered only those supplementing some newer method.

Growth and Spread of the Newer Hay-Harvesting Methods

The growth of these hay-harvesting methods is shown in table 3.

Table 3.- Experience with newer methods of harvesting hay, northwestern and east-north-central Ohio, 1941

Extent of experience	Number of farms, by method and extent of experience				
	Auto buck rake	Tractor buck rake	Pick-up baler	Stationary chopper	Field chopper
1 year, 1941 only	28	36	17	2	1
2 years, 1940-41	34	15	4	2	1
3 years, 1939-41	13	2	2	2	1
4 years, 1938-41	7	-	-	1	1
5 years, 1937-41	1	-	-	1	-
6 years, 1936-41	1	-	-	1	-
7 years, 1935-41	-	-	-	1	-
Total	84	53	23	10	3

The buck rake ^{1/} now spreading eastward into Ohio is a great improvement over the sweep rake, a horse driven hay tool common years ago throughout sections of the West where hay was stacked in the open. The first auto buck rake known to have been used in Ohio was built by a farmer in Van Wert County in 1935. In that area, auto buck rakes, built of scrap steel, largely native lumber, and used automobile parts by farmers and local welders, have continued to be much more numerous than tractor rakes, although their rate of increase in 1941 was less pronounced than in 1940. Tractor buck rakes are a relatively new development. They were almost as common as auto rakes in the Hardin-Bluffton area. All of the 22 buck rakes used on the 30 farms in the east-north-central part of the State made their appearance in 1941, and two-thirds of these were tractor rakes. Pick-up balers were the newest hay-harvesting equipment of all, three-fourths of the farmers who used this method having begun it in 1941. Chopping of dry hay was limited largely to the Hardin-Bluffton area, where it has been increasing slowly in importance since 1935; field choppers were first used in 1939.

^{1/} For information on the design and mechanical features of these tools see "Automotive Buck Rakes," by C. B. Kichey and K. D. Barden, Dept. of Agricultural Engineering, Ohio State University, Columbus, Ohio.

Relative Efficiency and Cost of the Different Methods

In order to show the relative economy of the various methods, costs of cutting and raking were disregarded and only the costs from windrow to mow were computed. Size of mowers varied from farm to farm, as did also the type of power used to pull them. Less than one-third of the mowers on farms using the auto buck rake method were drawn by tractors, while 70 percent of the operators harvesting all or part of their hay with pick-up balers used tractor-drawn mowers. The proportion of side-delivery rakes drawn by tractors likewise varied, ranging one-fourth of those on farms using auto buck rakes to two-thirds on farms using field choppers.

The buck rake was the cheapest means of collecting, transporting and storing hay (table 4). The wagon and loader method took 82 percent more labor per ton than did the auto buck rake, and more than three times as much horse and tractor work together; the use of wagons, loaders, slings and forks cost only a little more per ton of hay handled than did auto buck rakes, slings and forks. Total costs per ton from windrow to mow were 71 percent greater with the loader method than with auto buck rakes.

Tractor buck rakes were not quite as efficient as auto buck rakes, requiring about one-sixth more man labor for each ton of hay put into storage. The tractors, some of which were old models did not travel as fast as automobile rakes, and carried somewhat smaller loads. There is little reason, however, why a properly built tractor rake driven by a fast, modern tractor should not prove to be as efficient as an auto buck rake. The smaller amount of hay handled per hour by the tractor rakes included in this study, together with the greater hourly cost of tractors and rake attachments as compared with auto buck rakes, resulted in a one-third greater cost per ton for the tractor buck rake method.

It might be of interest to point out some of the mechanical differences in the two types of buck rakes. Auto buck rakes were almost universally mounted on the rear end of an old automobile or truck, and loaded by driving in reverse. Eighty of the 84 auto buck rakes were mounted in the rear, whereas, 49 of the 53 tractor rakes were mounted in front. Two-thirds of the tractor rakes were equipped with power lift, compared with 58 percent of the auto rakes; the others had hand-lifts.

Each type of buck rake has certain advantages and disadvantages. If an automobile is used, hay may be put up with more speed, driving visibility is better, and the tractor is more readily available for cultivating and other work. On the other hand more dust gets into the hay on the way to the barn, and if the automobile is an old worn out one the driver may experience considerable mechanical difficulty and delay. On a farm on which a tractor is owned, an additional automobile or truck adds to the investment and overhead expenses; a power lift for the buck rake is more easily secured on a tractor having a power take-off than on an automobile; and dust raised by the tractor wheels does not get into the hay. The front mounting, however, gives poor visibility in driving the tractor, leading to difficulties if gates or barn doors are narrow, and to possible danger if hay is hauled on a heavily traveled highway. Furthermore, the common method of mounting is apt to result in damage to front tires and front-wheel bearings of the tractor.

Costs for baled and chopped hay were higher than for long hay because of the additional processing involved. Differences in the nature of the final product must be kept in mind in these comparisons.

Table 4.- Cost of handling and storing dry hay, windrow to mcw, by different methods, Ohio, 1941

Method	Number of farms	Tons hay handled per farm	Number of men in crew	Tons per hour by the crew	Man hours per ton	Cost per ton, dollars 1/				Total
						Man labor	Horse work	Tractor work	Other machinery	
Wagons and loader	26	30	3.4	1.1	3.1	.73	.27	.20	.51	1.76
Auto buck rake	84	41	3.1	1.8	1.7	.43	.11	.04	.45	1.03
Tractor buck rake	53	35	2.6	1.3	2.0	.50	.15	.37	.55	1.37
Pick-up baler*	23	41**	3.2	1.2	2.7	.77	.03	.30	1.50	2.60
Stationary chopper, wagons and loader	4	60	5.4	1.5	3.0	.90	.20	.48	.87	2.45
Stationary chopper and buck rake	6	57	2.3	1.7	1.4	.35	-	.33	.84	1.52
Large field chopper	3	36**	3.6	2.9	1.2	.30	.06	.31	1.29	1.96

* Includes hauling and storing of bales.

** Excludes custom work away from the farm.

1/ In computing costs the following average rates were charged:

Man labor, other than hired		Slings or forks.....*	.03 per ton
baling.....*	.25 per hour	Hay loader.....	.30 per ton
Horse work.....	.15 per hour	Pick-up baler, owned.....	1.20 per ton
Tractor work.....	.45 per hour	(includes wire, and fuel for auxiliary motor)	
Use of auto.....	.35 per hour	Custom charge for baling.....	2.67 per ton
Buck rake attachment.....	.40 per hour	(includes 3.3 men, tractor and baler)	
Wagons.....	.08 per ton	Stationary chopper.....	.75 per hour
		Field chopper and blower, total.....	1.20 per ton

Note:

Rates for the different machines, and hence total costs, would vary from those reported here depending on how much more or less they were used than those in the study.

The pick-up baler method was used by 14 operators who owned their balers and by 9 others who hired their baling done. With considerable demand for baling and relatively few balers to do the work, the custom charge for baling alone ranged from \$2.50 to \$3.00 per ton and averaged \$2.67. This was nearly 50 percent more than the estimated cost of baling on the 14 farms on which pick-up balers were owned. Fixed charges for machinery overhead were held at a reasonably low cost per ton on the latter farms, because of the large amount of custom baling which these operators were able to do in 1941. To arrive at a cost which might prove to be more representative over a period of years it seemed better to consider the 23 farms as a group. The cost of \$2.00 per ton, reported in table 4, includes an average of \$2.06 baling costs with owned and custom outfits plus an average cost of \$0.54 per ton for hauling and storing the bales.

In connection with the amount of hay handled per hour by the baling crew it should be pointed out that an average of 2.5 tons per hour was baled and dropped in the field, but that the time for loading, hauling and storing the bales by a somewhat smaller crew (generally the same men in the case of the 14 operators who did their own baling) was almost as much as that spent in baling. Considering the men doing the baling and those storing the hay as a single crew, the total amount of hay baled and stored was thus 1.2 tons per hour.

Ten operators used stationary hay choppers or ensilage cutters to handle all or part of their field-cured hay. Four of these used loaders and wagons as a means of getting the hay to the chopper, 6 used buck rakes. Here the buck rake proved to have more of an advantage over the loader-wagon method than it did in handling long hay. Feeding the chopper from the pile of hay left by a buck rake was easier and took less time than feeding from a loaded wagon. The stationary chopper method with wagon and loader took more than two and one-half times as much man labor for each ton of hay put into storage as did hauling with a buck rake and running it through a chopper. Total cost for the chopper-loader method was 61 percent greater.

Large field choppers or forage harvesters were used on only three farms. It will be noted that this method handled more hay per hour than any other method. Total cost per ton was about 30 percent greater than in the stationary chopper-buck rake method because of larger machinery costs (table 4). These field choppers were utilized in harvesting an average of 86 tons of dry hay and about 100 tons of alfalfa silage per farm, in picking up some straw after the combine, and in doing a little custom work. Yet all of this together, requiring approximately 60 hours per farm, constituted a small annual use for the chopper and blower whose total original purchase price exceeded \$1,000.

Size and Organization of Hay-Making Crews

With buck rakes.— When a buck rake was used most of the hay was raked into windrows with a side delivery rake, as at one farmer in seven taking the hay direct from the swath. In order to get the maximum load, essential for greater economy on long hauls, many operators "double loaded" their buck rakes. One load is gathered and left on the ground while another is collected. This second load is then lifted by the rake and dropped on top of the first; the rake is then withdrawn and the entire lot is picked up and brought to the barn at one load. Another practice frequently found was that of bunching a considerable part of the day's hay with the buck rake as soon as it is dry enough to put in the mow, rather than leaving it in the windrow to dry out excessively.

With the lay in the winorow, most of the farmers who used a buck rake had a hay-making crew of three men, one to operate the buck rake, one in the mow, and one on the ground to handle the slings or grapple fork (table 5).

Table 5.- Distribution of farms, classified as to number of men in hay-harvesting crews, and by method, Ohio areas, 1941

Method	Number of farms, by size of crew						
	Total	1 man	2 men	3 men	4 men	5 men	6 men
Wagons and loader	26	-	6	13	3	-	4
Auto buck rake	84	3	17	39	22	3	-
Tractor buck rake	53	6	14	26	6	1	-
Pick-up baler:	23						
Baling		-	3	9	10	1	-
Hauling and storing		-	7	12	4	-	-
Stationary chopper, wagon and loader	4	-	-	-	1	1	2
Stationary chopper and buck rake	6	-	4	2	-	-	-
Large field chopper	3	-	-	1	1	1	-

When four men were on the job, two worked in the mow in about half the cases, while in other cases the fourth person drove the team to pull up the hay. A considerable number of operators using the buck rake made hay with a 2-man crew, one to handle the rake, the second mowing away the hay. Sometimes the latter also handled the slings or fork as well as the team to pull up the hay; in some cases the driver of the buck rake pulled the sling load up with the auto or tractor rake as he started back to the field. A few buck rake users did all of their hay-harvest work alone. These men would bring three buck rake loads to the barn, pulling each into the mow as a sling load. The third load would then be left hanging on the track while the other two were mowed away; it would then be dropped and scattered, and the process would be repeated. In this way it was necessary to climb to the mow only once for every ton or more of hay brought to the barn.

Small crews of course did not put up as much hay per day as larger crews, but they handled their hay with less man labor and at lower cost per ton (table 6).

Practically all factors that would influence cost were constant in these four groups of farms, so that differences in efficiency and cost were due largely to differences in size of crew. Distance to the field was fairly uniform except in the case of the 3 operators putting up their hay alone; yields were practically the same in all groups, averaging 1.15 tons per acre per cutting for all farms; and size of load hauled, as estimated by the farmers, varied less than 5 percent between groups, averaging 842 pounds per load on the 84 farms where automobile buck rakes were used. Operators using three-man crews put up considerably more hay per farm than those doing their work alone, but this factor was taken care of in the calculation of equipment costs.

Table 6.- Effect of size of crew on efficiency and cost of handling hay with auto buck rake, windrow to mow, 84 Ohio farms

Number of men in crew	Number of farms	Distance to field, rods	Tons of hay per farm	Tons per hour by the crew	Man hours per ton	Cost per ton, dollars 1/			
						Man labor	Horse and tractor	Other equip-ment	Total
1	3	103	20	0.9	1.1	.28	.05	.52	.85
2	17	85	29	1.4	1.4	.35	.12	.49	.96
3	39	84	50	1.8	1.7	.42	.16	.44	1.04
4 or more.	25	76	38	2.0	2.0	.50	.14	.43	1.07

1/ At rates given in table 4; buck rake attachments were charged at the same rate per ton on each group of farms rather than at cost, which would have varied because of differences in annual use.

The same trends in man labor requirements and cost per ton with different size crews were noted on farms using tractor buck rakes, total man labor varying from 1.4 to 2.4 hours per ton with 1-man and 4-man crews respectively. Here, even more than on farms using auto buck rakes, the larger crews were used when fields were near the barn. Those that were able to get along with smaller crews had more driving to do.

With pick-up balers.- Referring again to table 5, it will be noted that 3 or 4 men generally comprised the crew operating the pick-up baler; one drove the tractor, two handled the baling wires, and where a fourth man was employed he either fed the baler, if it were one requiring hand feeding, or rode on a flat-top trailer, drawn behind the baler, collecting and dumping the bales in piles to make loading easier. Two-man baling crews were used on balers tying automatically with twine, one man riding the baler alongside the tying mechanism, the other driving the tractor. Hauling and storing crews, made up of the same men on farms where balers were owned, consisted of from 2 to 4 men, generally 3.

With hay choppers.- When the hay was loaded on wagons, more than twice as many men were required as when a buck rake was used. In the latter case only two or three men were needed, one to operate the buck rake and one or two to feed the cutter. With field choppers, crews varied from 3 to 5 men.

Additional Factors Affecting Efficiency of Buck Rakes

Distance to the field.- On farms where the average distance from barn to hay field ranged from about 40 rods to a little more than half a mile, it was found that costs of putting up hay varied less than 20 percent when auto buck rakes were used and about 30 percent in the case of tractor rakes (table 7).

Table 7.- Relation of distance to field to efficiency and cost of handling hay with auto and tractor buck rakes

Type of buck rake and distance to field	Number of farms	Average distance to field	Men in crew	Tons of hay per hour	Man hours per ton	Cost per ton, dollars				
						Man labor	Horse and tractor	Other equip-ment	Total	
<u>Auto buck rakes:</u>										
20 to 59 rods	27	35	3.2	2.0	1.6	.41	.14	.42	.97	
60 to 99 rods	33	75	3.2	1.9	1.7	.43	.15	.45	1.03	
100 to 139 rods	10	118	3.1	1.7	1.8	.45	.15	.48	1.08	
140 rods & over	14	173	2.9	1.6	1.8	.46	.16	.53	1.15	
<u>Tractor buck rakes:</u>										
20 to 59 rods	19	38	2.6	1.4	1.8	.46	.46	.32	1.24	
60 to 99 rods	20	71	2.8	1.4	2.0	.50	.49	.34	1.33	
100 to 139 rods	4	117	2.4	1.1	2.2	.55	.56	.37	1.48	
140 rods & over	10	180	2.0	.9	2.2	.55	.57	.40	1.62	

When auto buck rakes were used the difference in total cost from windrow to mow amounted to an average of only 5 cents per ton for each additional 40 rods distance. This small additional cost is understandable when it is realized that an extra 40 rods would mean only six-tenths of a mile of added travel with the auto buck rake for each ton of hay, requiring not more than $2\frac{1}{2}$ minutes since half of the distance would be with an empty rake.

On farms utilizing tractor buck rakes, each additional 40 rods distance was accompanied by an increased cost amounting to approximately 10 cents per ton.

A considerable number of operators of large farms expressed the desirability of having two buck rakes to speed up the hay making process, thereby keeping the barn crew always fully occupied.

Although time lost on long hauls was reported to be a disadvantage in using buck rakes, it may be pointed out that the same factor is working when wagons and hay loaders are utilized. Thus farms using loaders were classified into two groups on the basis of distance to field. Those whose average distance was 65 rods had a cost of \$1.51 per ton from windrow to mow, while those having fields an average of 163 rods from the barn had a \$2.05 per ton cost. Even though wagon loads were 3 times as large as the loads hauled by buck rakes, this was much more than offset by the slower speed of travel, particularly when horses were used.

Slings vs. forks.- Slings were generally preferred for handling bucked-in hay and were found almost without exception on all farms having barns suitably constructed for their use. These slings were so made as to handle a buck rake load at a time, necessitating considerable clearance in the mow, strong rafters, and a good hay rope. Farmers not equipped with slings usually handled the hay with a four-pronged grapple fork, although this was a less efficient method because of the loose condition of the hay (table 8).

Table 8.- Relative efficiency and cost of handling hay from windrow to mow with slings and forks used in storing hay hauled in with buck rakes

Type of buck rake and equipment used in storing hay	Number of farms	Length of haul, rods	Tons per acre, cutting	Men per crew	Tons of hay per hour	Man hours per ton	Cost per ton, dollars		
							Man labor	Other costs	Total
<u>Auto buck rake:</u>									
Slings	74	83	1.1	3.1	1.9	1.6	.41	.59	1.00
Forks	10	82	1.2	2.8	1.3	2.2	.56	.69	1.25
<u>Tractor buck rake:</u>									
Slings	37	90	1.2	2.7	1.4	2.0	.50	.35	1.35
Forks	16	75	1.4	2.1	1.0	2.1	.53	.98	1.51

On the two groups of farms using auto buck rakes, where other factors influencing cost such as length of haul, yield, and number of men in the crew were similar, it was found that 37 percent more man labor was expended for each ton of hay handled with grapple forks, and that the total cost was 25 percent greater than when slings were used.

The same trend was noted on farms using tractor buck rakes. But here the group of farms utilizing forks showed to relatively less disadvantage because of other offsetting factors.

Differences in Machinery Investments

The seven different methods of harvesting hay varied widely in the extent and total value of the equipment used in the hay-making operations (table 9).

These lists include all equipment used in any phase of the hay making, although of course most of the items were used for many purposes other than hay making. It would be difficult indeed to allocate this equipment inventory to the various enterprises using it. Thus, buck rakes were used in handling grass silage, in threshing, in gathering combined straw, in hauling corn shocks to the husker shredder and green corn to the ensilage cutter, and in hauling corn stover and baled straw from the field; hay choppers were used in making large amounts of corn and grass silage; mowers were used in cutting clover for seed and in clipping meadows and wheat-stubble fields, side delivery rakes in raking green hay for silage and combined straw; and wagons for other hauling purposes.

Table 9.- Itemized list and value of equipment used, by hay-making method

Method and equipment used	Number of farms	Percent of farms reporting	Inventory value of equipment	
			Average per farm Reporting Dols.	Average per farm All farms Dols.
<u>Auto Buck rake</u>	84			
Tractor		35	612	211
Mower		100	50*	50
Side delivery rake		82	52*	43
Dump rake		7	11	1
Tedder		4	23	1
Auto buck rake		100	110*	110
Slings		38	5*	4
Forks		12	5	<u>1</u>
Total				421
<u>Tractor Buck rake</u>	53			
Tractor		100	584	584
Mower		100	57*	57
Side delivery rake		77	54*	42
Dump rake		2	15	-
Buck rake attachment		100	68*	68
Slings		70	3*	3
Forks		30	5	<u>2</u>
Total				756
<u>Loader</u>	26			
Tractor		54	686	369
Mower		100	57*	57
Side delivery rake		100	55*	55
Loader		100	54*	54
Wagons		92	37*	76
Truck		12	40.2	46
Slings		50	3*	5
Forks		50	4*	<u>2</u>
Total				664
<u>Pick-up Baler</u>	14			
Tractor		100	874	874
Mower		100	81*	81
Side delivery rake		100	74*	74
Pick-up baler		100	993**	993**
Trailer		21	23	5
Wagon		86	83*	71
Auto buck rake		7	120	9
Truck		7	400	<u>26</u>
Total				2140

* Inventory value of machines most commonly used, other than tractor.

** All of these 14 balers were purchased new in 1941; 3 cost an average of \$1,623 each, 11 others an average of \$811.

Continued

Table 9.- Itemized list and value of equipment used, by hay-making method
(Continued)

Method and equipment used	Number of farms	Percent of farms reporting	Inventory value of equipment	
			Average per farm reporting Dols.	Average per farm All farms Dols.
<u>Stationary chopper and Buck Rake</u>				
	6			
Tractor		100	825	825
Mower		100	76*	76
Side delivery rake		67	68*	45
Auto buck rake		83	111*	92
Tractor rake attachment		17	125	21
Stationary chopper		100	311*	311
Total				1370
<u>Stationary chopper and Loader</u>				
	4			
Tractor		100	900	900
Mower		100	88*	88
Side delivery rake		100	77*	77
Loader		100	95*	95
Wagons		75	103*	77
Truck		25	800	200
Stationary chopper		100	325*	325
Total				1762
<u>Field chopper</u>				
	3			
Tractor		100	1150	1150
Mower		100	78*	78
Side delivery rake		100	100*	100
Wagons (2)		100	140*	140
Truck		33	1000	333
Field chopper		100	718*	718
Blower		100	200*	200
Total				2719

Tractors shown in the list of equipment included in the auto buck rake method (table 9) were used for some of the cutting and raking, although this might have been done by horses, while a tractor was of prime necessity in the tractor buck rake method. Likewise, a tractor was indispensable with the pick-up baler method, and with field choppers two tractors were needed, one in the field and one at the blower. An electric motor might have been utilized to operate the latter as well as the stationary choppers.

Another way to show the relative valuations of hay equipment under each method would be to omit tractors from the calculation, in as much as they are utilized a relatively small proportion of the time in harvesting hay, and add together only those hay tools most commonly used. These totals are given in table 10, with separate totals for equipment used after the hay had been cut and raked into windrows.

Table 10.— Inventory value of hay tools, other than tractor, most commonly used on farms, classified by hay-harvesting method, 1941

Method	Total inventory value of hay equipment per farm	
	Including mower and side delivery rake Dollars	Excluding mower and side delivery rake Dollars
Auto buck rake	217	115
Tractor buck rake	184	73
Loader and wagons	253	141
Pick-up baler	1049	894
Stationary chopper and buck rake	566	422
Stationary chopper and loader	688	523
Large field chopper	1236	1058

It is of interest to note how the difference between the two columns, representing the valuation of mower and side delivery rake, increased with increasing valuation of the other hay tools. A larger proportion of the highly mechanized farms had tractor mowers.

Advantages and Disadvantages of the Newer Methods

Each farmer was asked to state in what respects he found it advantageous to use one or more of the new hay-harvesting methods (rather than the loader method which all had used at some time), and to tell what he regarded as its disadvantages or objectionable features (table 11).

The buck rake methods were outstanding as regards the high degree of satisfaction expressed by their users. The reported better quality of hay was largely associated with the smaller amount of leaf shattering than when loaders were used, as well as to the shortened haying season. The smaller labor requirements of the buck rake methods have been discussed earlier in the report. The elimination of heavy work both in the field and in the mow were strongly stressed; this made it possible to utilize boys and even women to a larger extent than was possible in other methods. The loose, untrapped condition of bucked-in hay made mowing away especially easy when slings were used.

Table 11.- Advantages and disadvantages of newer hay-harvesting methods when compared with the wagon-loader method

Points	Number of operators reporting each point, by harvesting method employed				
	Auto buck rake 84 farms	Tractor buck rake 53 farms	Pick-up baler 23 farms	Stationary chopper 10 farms	Field croppers 3 farms
<u>Advantages:</u>					
Hay is of better quality	62	39	15	6	2
Easier work in the field	50	33	5	3	1
Less time spent haying	47	23	8	3	2
Less help needed	42	30	3	5	1
Hay mows away more easily	38	20	2	-	-
Less storage space needed	-	-	15	-	2
Cheaper if hay to be sold	-	-	6	-	-
Less hay wasted by stock	-	-	-	4	1
<u>Disadvantages:</u>					
Time wasted on long hauls	7	12	-	-	-
Hay is dustier	11	5	-	2	1
Old cars give trouble	8	-	-	-	-
Tractor trouble a/c mounting	-	5	-	-	-
More hay scattered in field, etc.	6	4	-	-	-
Wider gates needed	4	6	-	-	-
More storage space required	3	2	-	-	-
Danger of spoilage is greater	-	-	4	1	-
Additional cash expenses	-	-	3	1	1
Difficult to secure custom baler	-	-	4	-	-
Greater machinery investment	-	-	3	-	2
Buyers object to small bales	-	-	2	-	-

Improved quality of hay, with respect to leanness and color, and the saving of storage space were the advantages most frequently reported for pick-up balers. The fact that baled hay requires much less storage space made it possible for these operators to store more feed and bedding under cover and to hold any surplus hay for a possible rise in price. Those who had hay to sell found this method considerably cheaper than storing long hay and later baling it out of the mow. More advantageous use of storage space was an important feature in the use of chopped hay; it not only requires much less space per ton but can be blown into lofts beneath low shed roofs where storage of long hay would be out of the question.

Relatively few objectionable features were reported for any of the newer hay-harvesting methods, the advantages far outweighing the disadvantages. It is believed that the latter, as set forth in table 11, are in need of no additional comment.

Will these Methods Continue to be Used?

These new methods of harvesting hay gave almost universal satisfaction to the farmers using them. Many were very enthusiastic in their praise.

Only one of the 84 operators using auto buck rakes was dissatisfied with the results he obtained in 1941, and said that he did not intend to use the rake again. It was a commercially made rake, mounted on the front of a small truck. The farmer declared that it was too slow for his large farm, its capacity being only about 600 rounds at a load.

Five of the 53 tractor rake operators are discontinuing their use in 1942. Two of these tractor buck rakes were commercial outfits, three home-made; three had hand lifts, two had power lifts; three operators stated that the teeth could not be raised high enough to give proper clearance; two said they had difficulty in gathering a sufficiently large load; and only one of the five farms was equipped with slings; the others depending on forks to carry the hay into the mow. One of these five men owned a pick-up baler, and two others indicated that they could either buy or hire one of them in 1942.

Only one of the 23 operators using a pick-up baler was not satisfied with this method. He felt that the charge for custom baling was too costly and said that the risk of getting a baler at the proper time was too great.

None of the 13 farmers who chopped all or part of their hay in 1941 were dissatisfied with the results. All are continuing the practice next harvest.

The relatively small percentage of farmers who have discontinued the use of these time- and labor-saving practices, coupled with the growing interest on the part of farmers in all methods of conserving man power, will undoubtedly lead to a rapid expansion of these new hay-harvesting methods. Shortages of steel and rubber tires may check the expansion along some lines.

Summary

This report presents data collected in a study covering 167 northwestern and east-north-central Ohio farms on which one or more of the newer hay-harvesting methods were used in 1941.

Eighty-four of these operators used auto buck rakes and 53 had buck rakes mounted on tractors; pick-up balers were used on 22 farms, stationary hay choppers on 10 farms, and 3 operators had field combine harvesters. Twenty-six operators used hay loaders to supplement one of the other methods.

The buck rake was the cheapest method of getting hay from the windrow to the mow. To handle a given amount of hay, the fork and loader method required 32 percent more man labor than did the auto buck rake and involved a total cost that was 71 percent greater. Tractor buck rakes were not quite as efficient as auto rakes, largely because of slower speed; harvesting costs from windrow to mow were about one-third larger for tractor rakes. Each type of buck rake has its advantages and disadvantages, and each has strong advocates among its users.

Costs for baled and chopped hay were higher than for long hay because of the additional processing involved.

Buck rakes also showed to good advantage over the use of loader and wagons as a means of collecting and transporting hay to the stationary chopper. Less than half as much labor was expended for each ton run through the chopper when the hay was delivered with a buck rake.

Large field choppers, involving a considerably higher machinery investment, put chopped hay into the mow at approximately 30 percent increase in cost over the stationary chopper - buck rake method. These forage harvesters, with a crew about as large as that employed in the loader method in handling long hay, harvested about $2\frac{1}{2}$ times as much hay per hour as was handled by that method, and required less man labor per ton than any of the other methods studied.

Field baling was especially advantageous on farms having more hay than was needed for feed. Pick-up baler crews were usually composed of 3 or 4 men, baling an average of 2.5 tons per hour. Greater economies might well be worked out in gathering and storing the bales, since this took almost as much man labor per ton as the baling itself.

Starting with hay in the windrow, most buck rake users had a hay-making crew of 3 men, one to operate the buck rake, one in the mow and one to handle the slings or grapple fork. Smaller crews handled less hay per hour, but did it with a decreased expenditure of man labor and other costs per ton.

Slings, built to handle a buck rake load at a time, were preferred to grapple forks because of the loose condition of the hay. For economy of labor, it is essential that the hay be cleared away before the driver of the buck rake returns with another load. Other things being equal, the cost of putting up hay with buck rakes was reduced considerably by the use of slings.

Length of haul was not an important factor affecting costs on farms utilizing buck rakes where distance from barn to field ranged from 40 rods to about half a mile. Within this range, an additional 40 rods distance was accompanied by an increased cost of 5 cents per ton when auto buck rakes were used, about 10 cents per ton in the case of tractor rakes. The use of two buck rakes may be desirable for the longer hauls.

Each of these methods of hay harvesting has its favorable features, although none is without some minor disadvantage. In view of the large proportion of satisfied and enthusiastic users of the newer hay-harvesting methods found in this study, together with the growing shortages of farm labor, it is to be expected that these methods will undergo considerable expansion.

