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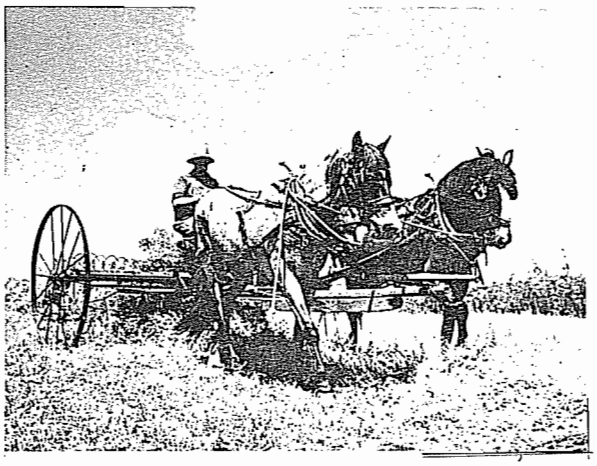
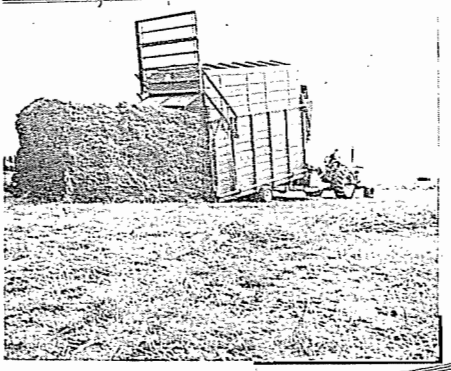
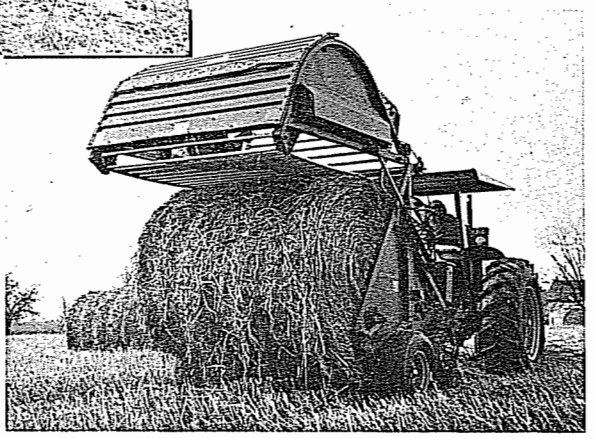




An Economic Analysis of

HAY HARVESTING SYSTEMS in North Dakota



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FOREWORD

This report represents a continuation of investigation of factors influencing the profitability of livestock production in North Dakota. The research for this project was conducted under North Dakota Agricultural Experiment Station Project Hatch 1352 entitled "Economics of Livestock Production."

This report presents information on hay harvesting and feeding costs. The data for this study were primarily from secondary sources. This report is concerned with haying costs for tame hay. A separate report has been prepared for native haying costs. The intent of this report is to provide information which is helpful to farmers and ranchers in their decision making.

The authors wish to extend appreciation to those who contributed to this study. The authors acknowledge the encouragement and valuable suggestions received from their colleagues in the Department of Agricultural Economics. Professor LeRoy W. Schaffner, Dr. Robert D. Carver, and Dr. Roger G. Johnson provided assistance from the beginning of this study.

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HIGHLIGHTS

The purpose of this study was to provide hay producers with information useful in decision making. The results of this study provide farmers with cost information helpful when selecting a hay harvesting system. The basic data were obtained from three sources: a mail survey of hay producers, personal telephone interviews with machinery dealers, and secondary sources. Budgeting was used to arrive at the costs for each system.

Eleven tame hay harvesting systems were considered in this study. These systems ranged from labor intensive to capital intensive. The systems were divided into three groups: Group 1, small capacity systems; Group 2, medium capacity systems; and Group 3, large systems.

Four hay feeding systems were combined with the 11 harvesting systems. The hay feeding systems were: for standard size baled hay, big bale, haylage, and loose hay.

Hay losses are also an expense to the farmer who feeds hay. Hay losses are of two types, storage losses and feeding losses. Storage losses result primarily from the effects of weather on the hay stored with no shelter. Feeding losses result from cattle wasting hay which has been fed to them.

The total haying costs include hay harvesting costs, hay feeding costs, and hay losses. The harvesting and feeding costs include the fixed costs associated with the ownership of the equipment used plus the variable costs of operating the machinery. Labor was included as a variable cost at $2 per hour. Losses associated with storage and feeding were valued at the market price for hay. These costs are calculated by adding fixed costs for hay harvesting and hay feeding to get total annual fixed cost. The variable costs per ton are calculated by adding variable cost per ton for hay harvesting and

hay feeding and the cost of hay losses per ton. After these two costs are known, the total annual costs and costs per ton can be figured.

Group 1 contains baling and manually stacking bales, bale accumulator, and loader loose hay stacking systems. In this group the loader loose hay stacking system has the lowest cost per ton total haying costs. Group 2 contains small automatic bale wagon, small big baler, small hay chopping system, and small loose hay stacking wagon system. In this group the small big baler system had the lowest cost per ton total hay costs. Group 3 contains large automatic bale wagon, large big baler, large hay chopping system, and large loose hay stacking wagon system. In this group the large big baler system had the lowest cost per ton total haying costs.

AN ECONOMIC ANALYSIS OF HAY HARVESTING SYSTEMS IN NORTH DAKOTA

by
Randal C. Coon and F. Larry Leistritz

Cattle provide North Dakota farmers with an important source of income. In 1972 total receipts from sales of cattle and calves accounted for 23.9 percent of total farm income and an additional 3.6 percent was attributed to dairy product sales.[1] This high proportion of total farm income from cattle is reflected in the increase of all cattle on farms from 2,088,000 on January 1, 1963, to 2,435,000 head on January 1, 1973.[2] To feed these cattle, a large amount of hay must be harvested each year.

North Dakota ranked ninth in the United States in the production of all hay in 1972.[3] Haying has historically been one of the most labor-intensive operations for farmers. With an increased need for hay, but a drastically reduced amount of labor available to harvest it, the farmer is put in a difficult situation. With a shortage of labor, he is faced with the decision of cutting back his cattle enterprise or switching to a capital intensive hay harvesting system with a low labor requirement. Technology has added several new hay harvesting systems in recent years. Farmers can choose from a long list of hay harvesting systems ranging from a labor intensive, low investment system to a capital intensive, one-man hay harvesting system. A system can be selected to match each farmer's available labor and capital and have the capacity necessary for timely completion of hay harvesting.

Objectives of the Study

The primary purpose of this study was to determine the most feasible method of hay harvesting for a North Dakota farmer with his given set of resources. The specific objectives of this study were to:

1. Determine costs and resource requirements of various tame hay harvesting systems.
2. Determine costs and resource requirements of hay feeding systems.
3. Determine the economic feasibility of capital intensive hay harvesting systems, given the various enterprise sizes and resource situations.

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[1]United States Department of Agriculture, Economic Research Service, Farm Income State Estimates, 1959-72, FIS 222 Supplement, Washington, D.C., August, 1973.

[2]United States Department of Agriculture, Economic Research Service, Statistical Reporting Service, Agricultural Marketing Service, Livestock and Meat Statistics, Statistical Bulletin No. 522, July, 1973.

[3]Taylor, Fred R., and J. R. Price, North Dakota Crop and Livestock Statistics, Agricultural Statistics No. 29, Statistical Reporting Service, United States Department of Agriculture, and Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, May, 1973, p. 1.

Procedure

The data summarized in this report were from several sources. A mail survey was conducted to obtain information on machinery complements used for each budget. Machinery and equipment and fuel costs were obtained from businesses in Cass County. Other data necessary for arriving at the costs for each system were obtained from secondary sources. Budgeting was used to arrive at the costs of hay harvesting, feeding, and total haying cost.

COST THEORY AND ASSUMPTIONS

Costs in farm production fall into two main categories, fixed and variable costs. Fixed costs are the costs associated with the ownership of machinery and equipment which occur regardless of the amount of use. Fixed costs do not change with use, but remain constant at all levels of production. Variable costs are the production expenses which occur due to use of machinery or equipment. These costs, also referred to as operating costs, vary with the amount of use; and if the machinery is not used, no operating costs occur.

Fixed Costs

The fixed costs include depreciation, interest on investment, shelter, insurance, and taxes. Depreciation is the loss in value and service capacity due to normal wear in use, obsolescence, accidental damage, rust, corrosion, and weathering. A straight-line method of depreciation was used for this study. The formula used to figure depreciation is:

$$\text{Depreciation} = \frac{\text{New Cost - 10\% Salvage}}{\text{Years to Wear Out}}$$

Interest on investment is a charge made for the use of capital. Since money invested in machinery is unavailable for alternative uses, a reasonable charge is made for it. Average investment of a machine is new cost plus salvage, divided by two. A rate of 8 percent was used on the average investment of the machine to get interest on investment.

Insurance is the charge for the risk of loss due to fire, theft, vandalism, windstorms, and other hazards. The cost of this protection is represented by insurance premiums paid. Many farmers shelter their equipment because continual exposure to the weather will lower the value of farm equipment. Thus, a charge should be made for shelter. The annual cost of shelter and insurance is 1 percent of the original cost of the machinery.[4]

Taxes were not charged on any machinery in this study because state laws of North Dakota do not require farm machinery to be assessed and taxed yearly.

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[4]Maish, L. J., C. H. Cuykendall, and P. R. Hasbargen, Economic Comparisons of Hay Harvesting, Storing, and Feeding Systems for Beef Cow Herds, Economic Study Report S 69-5, Agricultural Experiment Station, Department of Agricultural Economics, University of Minnesota, St. Paul, Minnesota, October, 1969.

The sales taxes paid by farmers at the time of purchase are reflected in the purchase price of the machines.

Variable Costs

Variable costs include fuel, repairs, lubrication, supplies, and labor. These costs vary directly with the number of hours a machine is used. The more the machine is used, the higher these costs will be. The cost of fuel is very important in determining the total cost of operating farm machinery. The fuel costs for this study were based on the Nebraska tractor test data (Appendix Table 1).

Repairs are difficult to estimate because there are so many factors that influence the need for repairs. The repair costs include the cost for repairs and the labor to do the work. The repair costs for this study are expressed as a percentage of the original cost of the machine (Appendix Table 2).

Lubrication includes such items as grease, oil, and filters, in addition to the labor necessary to do the lubricating. Lubrication costs are usually proportional to the amount of fuel used. A rate of 15 percent of the fuel costs was used as the cost of lubrication of the farm machinery.[5] Fuel and lubrication costs are presented in Appendix Table 3.

Other variable costs that are incurred and are a direct relation to use can be grouped into a category called supplies. The major item under supplies is twine. A twine charge of $.60 per ton was made for standard size baled hay and a charge of $.15 per ton for big bales. The labor used to harvest the hay was figured at $2.00 per hour. This included all hired labor and the labor of the farmer and his family.

Custom Rates

Custom rates are useful for determining the minimum tonnage for an economical hay harvesting system. The tonnage harvested necessary to achieve a cost per ton equal to the custom rate indicates the minimum economic volume for a particular hay harvesting system. The 1971 custom hay harvesting rates for North Dakota were as follows:[6]

Swathing Hay:	$1.51 per ton
Baling Hay:	4.44 per ton
Chopping Hay:	5.32 per ton

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[5]Rice, Billy B., and Douglas H. Eidsvig, Machinery Costs for Crop Production, Circular A-524, Agricultural Experiment Station, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota.

[6]Taylor, Fred R., and J. R. Price, Custom Farm Work Rates, Statistical Reporting Service, United States Department of Agriculture and Agricultural Experiment Station, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, April 5, 1972.

A price index change of 1.164 was used to adjust these costs to 1973 costs.[7] A $6.00 per ton cost was used for hauling and stacking bales.[8] This gave a custom rate for the complete hay harvesting operation for tame hay of $12.93 per ton. The cost of having the complete hay chopping operation done by custom workers would be $7.95 per ton.

HAY HARVESTING BUDGETS

Hay harvesting budgets were constructed to compare the costs of harvesting various tonnages of hay with different systems. Budgets were figured for the following systems: baling and manually stacking bales, a bale accumulator system, a small automatic bale wagon system, a large automatic bale wagon system, a small big baler system, a large big baler system, a small hay chopping system, a large hay chopping system, a small loose hay stacking wagon, a large loose hay stacking wagon, and a loader loose hay stacking system. Tame hay is usually cut with a swather, while native hay is usually cut with a mower and raked into windrows. For this study, all the systems were set up with a swather because they were assumed to harvest tame hay. Because tractors and swathers are not used completely for haying, it was necessary to allocate only a part of the machine investment to haying so that the total investment figure accurately reflects the amount of value that machine has in the hay harvesting system. Tractors were allocated at a rate of 13.5 percent of total investment to hay harvesting, and swathers were allocated 25 percent to hay harvesting. Since North Dakota farmers often own different size tractors, for systems where more tractors were available than required to harvest his hay, the 13.5 percent allocation per required tractor was spilt between available tractors according to the amount of use for the operation it performed.

The machinery costs and capacities are very important in setting up hay harvesting budgets. The 1973 machinery list prices used for this study are presented in Appendix Table 4. The machinery was equipped with standard equipment and only those options necessary for haying (example: no cabs or duals were included). The machinery capacities are important in determining costs on a per ton basis. The haying machinery capacities (Appendix Table 5) used for this study are based on a one ton per acre average yield.

Baling and Manually Stacking Bales

The hay is first cut with a self-propelled swather with this system. The hay is harvested by pulling a wagon behind the baler with two men on the wagon to stack the bales. The baler must be stopped to unload the bales from the wagon. The loaded wagon must be hauled to the storage area where the bales

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[7] Agricultural Prices, United States Department of Agriculture, Statistical Reporting Service, Washington, D.C., December 15, 1971, and November 15, 1973.

[8] Long, James T., and Wayne D. Taylor, Hay Harvesting Costs $$$$$ in Texas, Bulletin No. B-1117, Agricultural Experiment Station, Texas A&M University, College Station, Texas, December, 1973.

are unloaded and stacked by three men for storage until the bales are to be fed. Three workers are required for this hay harvesting system.

The machinery necessary for harvesting hay by this method is:

Swather: 14' self-propelled
Baler: Power take-off, twine-tie, medium size
Wagon: 12' flatbed
Tractor: 60-75 horsepower, used at 75 percent load

The total allocated investment for this hay harvesting system was $5,701.15.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 57.10
Depreciation		490.57
Interest		251.25
Total Fixed Costs		$ 798.92

Variable Costs Per Ton:

Swather:		
Labor	.36	
Gas	.14	
Lubrication	.02	
Repairs	.08	$ .60
Tractor and Baler:		
Labor	.32	
Fuel	.22	
Lubrication	.03	
Repairs	.17	
Twine	.60	1.34
Three Men Stacking Hay on a Wagon and Unloading:		
Labor	6.66	
Repairs	.07	6.73
Total Variable Costs Per Ton		$ 8.67

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 1.

TABLE 1. COSTS FOR BALING AND MANUALLY STACKING BALES HAY HARVESTING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$798.92	$ 433.50	$1,232.42	$15.98	$8.67	$24.65
250	798.92	2,167.50	2,966.42	3.20	8.67	11.87
500	798.92	4,335.00	5,133.92	1.60	8.67	10.27
750	798.92	6,502.50	7,301.42	1.06	8.67	9.74
1,000	798.92	8,670.00	9,468.92	.80	8.67	9.47

Bale Accumulator System

The hay harvested with this system is cut with a self-propelled swather. A larger tractor is used to pull the baler and the bale accumulator. The accumulator drops the bales in groups of eight, which can be picked up by a special fork on the tractor mounted loader. The smaller tractor was used for the loader which loads the eight-bale groups on to a wagon. The bales are then hauled to an area where they are unloaded and stacked by means of the loader and special fork for storage until they are to be fed. Two workers were required for this hay harvesting system.

The machinery necessary for harvesting hay by this method is:

Swather: 14' self-propelled
Baler: Power take-off, twine-tie, medium sized
Bale accumulator: Eight-bale type
Wagon: 12' flatbed
Tractor: 60-75 horsepower, used at 75 percent load
Tractor loader with fork: 40-55 horsepower, used at 50 percent load

The total allocated investment for this hay harvesting system was $9,561.95.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 95.62
Depreciation		880.10
Interest		420.73
Total Fixed Costs		$1,396.45

Variable Costs Per Ton:

Swather:			
Labor	.36		
Gas	.14		
Lubrication	.02		
Repairs	.08	$	.60
Tractor, Baler with Bale Accumulator:			
Labor	.32		
Fuel	.22		
Lubrication	.03		
Repairs	.22		
Twine	.60		1.39
Tractor with Loader and Wagon:			
Labor	.62		
Fuel	.25		
Lubrication	.04		
Repairs	.14		1.05
Total Variable Costs Per Ton		$	3.04

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 2.

TABLE 2. COSTS FOR BALE ACCUMULATOR HAY HARVESTING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$1,396.45	$ 152.00	$1,548.45	$27.93	$3.04	$30.97
250	1,396.45	760.00	2,156.45	5.59	3.04	8.63
500	1,396.45	1,520.00	2,916.45	2.79	3.04	5.83
750	1,396.45	2,280.00	3,676.45	1.86	3.04	4.90
1,000	1,396.45	3,040.00	4,436.45	1.40	3.04	4.44

Small Automatic Bale Wagon System

The hay harvested with this system is cut with a self-propelled swather. A larger tractor pulls the baler which drops the bales on the ground. The bales are removed from the field by an automatic bale wagon pulled by a smaller tractor. The automatic bale wagon picks up the bales, stacks them, and then unloads and stacks them where they are to be stored until fed. Two workers were required for this hay harvesting system.

The hay harvesting machinery used in this system is:

Swather: 14' self-propelled
Baler: Power take-off, twine-tie, medium size
Automatic bale wagon: Pull-type, medium size
Tractor: 60-75 horsepower, used at 75 percent load
Tractor: 40-55 horsepower, used at 50 percent load

The total allocated investment for this hay harvesting system was $10,944.45.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 109.45
Depreciation		954.64
Interest		481.56
	Total Fixed Costs	~~$1,454.64~~ $1,545.64

Variable Costs Per Ton:

Swather:		
Labor	.36	
Gas	.14	
Lubrication	.02	
Repairs	.08	$ .60
Tractor and Baler:		
Labor	.32	
Fuel	.22	
Lubrication	.03	
Repairs	.17	
Twine	.60	1.34

Tractor and Automatic Bale Wagon:		
Labor	.30	
Fuel	.12	
Lubrication	.02	
Repairs	.24	.68
Total Variable Costs Per Ton		$ 2.62

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 3.

TABLE 3. COSTS FOR SMALL AUTOMATIC BALE WAGON HARVESTING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$1,545.64	$ 131.00	$1,676.64	$30.91	$2.62	$33.53
250	1,545.64	655.00	2,200.64	6.18	2.62	8.80
500	1,545.64	1,310.00	2,855.64	3.09	2.62	5.71
750	1,545.64	1,965.00	3,510.64	2.06	2.62	4.68
1,000	1,545.64	2,620.00	4,165.64	1.55	2.62	4.17

Large Automatic Bale Wagon System

The hay is cut with a self-propelled swather for this system. A larger tractor is used to pull the baler which drops the bales on the ground. The bales are removed from the field by an automatic bale wagon which loads and stacks the bales. They are then hauled to an area where they are unloaded and stacked for storage until they are fed. The smaller tractor is used on the automatic bale wagon. Two workers were required for this hay harvesting system.

The machinery used in this hay harvesting system is:

Swather: 16' self-propelled
Baler: Power take-off, twine-tie, large size
Automatic bale wagon: Pull-type, large size
Tractor: 80-95 horsepower, used at 75 percent load
Tractor: 60-75 horsepower, used at 50 percent load

The allocated investment for this hay harvesting system was $13,861.55.

The costs for this system were:

Fixed Costs:

Shelter and Insurance	$ 138.62
Depreciation	1,201.85
Interest	607.91
Total Fixed Costs	$1,950.38

Variable Costs Per Ton:

Swather:			
Labor	.26		
Gas	.14		
Lubrication	.02		
Repairs	.06	$	.48
Tractor and Baler:			
Labor	.26		
Fuel	.25		
Lubrication	.04		
Repairs	.18		
Twine	.60		1.33
Tractor and Automatic Bale Wagon:			
Labor	.26		
Fuel	.14		
Lubrication	.02		
Repairs	.26		.68
Total Variable Costs Per Ton		$	2.49

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 4.

TABLE 4. COSTS FOR LARGE AUTOMATIC BALE WAGON HARVESTING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	AFC	AVC	TC	AFC	AVC	ATC
50	$1,950.38	$ 124.50	$2,074.88	$39.01	$2.49	$41.50
250	1,950.38	622.50	2,572.88	7.80	2.49	10.29
500	1,950.38	1,245.00	3,195.38	3.90	2.49	6.39
750	1,950.38	1,867.50	3,817.88	2.60	2.49	5.09
1,000	1,950.38	2,490.00	4,440.38	1.95	2.49	4.44

Small Big Bale System

The hay is cut with a self-propelled swather for this system. The hay is harvested with a big baler. The big baler makes 1,500-pound, large, round bales by rolling the hay into a big round bale. A special big bale carrier is used to carry one big bale at a time from the field to a location for storage until it is to be fed. One worker was required for this hay harvesting system.

The machinery required to harvest hay with this system is:

Swather: 14' self-propelled
Big baler: Power take-off, medium size, 1,500-pound bales
Big bale carrier: One 1,500-pound bale at a time
Tractor: 60-75 horsepower, used at 75 percent load

The total allocated investment for this hay harvesting system was $6,915.15.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 69.15
Depreciation		~~604.50~~ 604.05
Interest		304.27
	Total Fixed Costs	$ 977.47

Variable Costs Per Ton:

Swather:		
Labor	.36	
Gas	.14	
Lubrication	.02	
Repairs	.08	$ .60
Tractor and Big Baler:		
Labor	.34	
Fuel	.23	
Lubrication	.04	
Repairs	.22	
Twine	.15	.98
Tractor and Bale Carrier:		
Labor	.44	
Fuel	.24	
Lubrication	.04	
Repairs	.03	.75
	Total Variable Costs Per Ton	$ 2.33

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 5.

TABLE 5. COSTS FOR SMALL BIG BALE HARVESTING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$977.47	$ 116.50	$1,093.97	$19.55	$2.33	$21.88
250	977.47	582.50	1,559.97	3.91	2.33	6.24
500	977.47	1,165.00	2,142.47	1.95	2.33	4.29
750	977.47	1,747.50	2,724.97	1.30	2.33	3.63
1,000	977.47	2,330.00	3,307.47	.98	2.33	3.31

Large Big Bale System

The hay is cut with a self-propelled swather for this system and is harvested with a big baler. This big baler makes 2,500-pound, large, round bales by rolling the hay until it becomes a big round bale. A special bale carrier is used to carry one bale at a time from the field to the location where it is to be stored until fed. One worker was required for this hay harvesting system.

The machinery used to harvest hay with this system is:

Swather: 16' self-propelled
Big baler: Power take-off, large size, 2,500-pound bales
Big bale carrier: One 2,500-pound bale at a time
Tractor: 80-95 horsepower, used at 75 percent load

The total allocated investment for this hay harvesting system was $8,848.90.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 88.49
Depreciation		767.67
Interest		389.35
Total Fixed Costs		$1,245.51

Variable Costs per Ton:

Swather:		
Labor	.26	
Gas	.14	
Lubrication	.02	
Repairs	.06	$ .48
Tractor and Big Baler:		
Labor	.26	
Fuel	.25	
Lubrication	.04	
Repairs	.24	
Twine	.15	.94
Tractor and Bale Carrier:		
Labor	.26	
Fuel	.20	
Lubrication	.03	
Repairs	.03	.52
Total Variable Costs Per Ton		$ 1.94

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 6.

TABLE 6. COSTS FOR LARGE BIG-BALE HARVESTING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$1,245.51	$ 97.00	$1,342.51	$24.91	$1.94	$26.85
250	1,245.51	485.00	1,730.51	4.98	1.94	6.92
500	1,245.51	970.00	2,215.51	2.49	1.94	4.43
750	1,245.51	1,455.00	2,700.51	1.66	1.94	3.60
1,000	1,245.51	1,940.00	3,185.51	1.25	1.94	3.19

Small Hay Chopping System

The hay is cut with a self-propelled swather with this system. It is then chopped with a forage harvester with a hay head on it at about 40 percent moisture. The hay is chopped into forage wagons. The largest tractor is used on the chopper, while a medium-sized tractor is used to haul the forage wagons from the field to the haylage pile where the hay was unloaded and packed. The smallest tractor was used to pack the chopped hay. The haylage was stored in the pile until fed. Three workers were required for this hay harvesting system.

The machinery used to harvest hay with this system is:

Swather: 14' self-propelled
Forage harvester: Power take-off, medium size with hay head
Forage wagons (2): Medium size
Tractor: 80-95 horsepower, used at 75 percent load
Tractor: 60-75 horsepower, used at 50 percent load
Tractor: 40-55 horsepower, used at 50 percent load

The total allocated investment for this hay harvesting system was $12,011.35.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 120.11
Depreciation		1,009.04
Interest		528.50
	Total Fixed Costs	$1,657.65

Variable Costs Per Ton:

Swather:			
Labor	.36		
Gas	.14		
Lubrication	.02		
Repairs	.08	$	.60
Tractor and Chopper, Tractor and Two Forage Wagons, and Tractor to Pack Haylage:			
Labor	.66		
Fuel	.42		
Lubrication	.06		
Repairs	.20		1.34
	Total Variable Costs Per Ton	$	1.94

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 7.

Large Hay Chopping System

With this system the hay is cut with a self-propelled swather. The hay is then chopped with a forage harvester with a hay head on it at about

TABLE 7. COSTS FOR SMALL HAY CHOPPING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$1,657.65	$ 97.00	$1,754.65	$33.15	$1.94	$35.09
250	1,657.65	485.00	2,142.65	6.63	1.94	8.57
500	1,657.65	970.00	2,627.65	3.32	1.94	5.26
750	1,657.65	1,455.00	3,112.65	2.21	1.94	4.15
1,000	1,657.65	1,940.00	3,957.65	1.66	1.94	3.60

40 percent moisture. The hay is chopped into forage wagons. The largest tractor is used on the chopper, a medium-size tractor is used to haul forage wagons from the field to the pile, and a small tractor was used to pack the haylage. Three workers were required for this hay harvesting system.

The machinery used to harvest hay with this system is:

Swather: 16' self-propelled
Large harvester: Power take-off, large size with hay head
Forage wagons (2): Large size
Tractor: 95-120 horsepower, used at 75 percent load
Tractor: 60-75 horsepower, used at 50 percent load
Tractor: 40-55 horsepower, used at 50 percent load

The allocated investment for this hay harvesting system was $14,749.80.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 147.95
Depreciation		1,253.65
Interest		650.97
Total Fixed Costs		$2,052.57

Variable Costs Per Ton:

Swather:		
Labor	.26	
Gas	.14	
Lubrication	.02	
Repairs	.06	$ .48
Tractor and Chopper, Tractor and Two Forage Wagons, and Tractor to Pack:		
Labor	.54	
Fuel	.38	
Lubrication	.06	
Repairs	.17	1.15
Total Variable Costs per Ton		$ 1.63

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 8.

TABLE 8. COSTS FOR LARGE HAY CHOPPING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$2,052.57	$ 81.50	$2,134.07	$41.05	$1.63	$42.68
250	2,052.57	407.50	2,460.07	8.21	1.63	9.84
500	2,052.57	815.00	2,867.57	4.11	1.63	5.74
750	2,052.57	1,222.50	3,257.07	2.74	1.63	4.37
1,000	2,052.57	1,630.00	3,682.57	2.05	1.63	3.68

Small Loose Hay Stacking Wagon System

The hay is cut with a self-propelled swather for this system. It was then harvested with a loose hay stacking wagon. The stacking wagon picks up the swathed hay and blows it into a wagon where it is compressed into a tight three-ton loose haystack. The haystack is hauled to an area where it is unloaded from the stacking wagon and stored until fed. One worker was required for this hay harvesting system.

The machinery required for this hay harvesting system is:

Swather: 14' self-propelled
Stacking wagon: Three-ton stacks
Tractor: 60-75 horsepower, used at 75 percent load

The total allocated investment for this hay harvesting system was $10,590.15.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 105.90
Depreciation		947.59
Interest		465.97
Total Fixed Costs		$1,519.46

Variable Costs Per Ton:

Swather:		
Labor	.36	
Gas	.14	
Lubrication	.02	
Repairs	.08	$ .60

Tractor and Stacking Wagon:		
Labor	.30	
Fuel	.21	
Lubrication	.03	
Repairs	.40	.94
Total Variable Costs Per Ton		$ 1.54

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 9.

TABLE 9. COSTS FOR SMALL LOOSE HAY STACKING WAGON HARVESTING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$1,519.46	$ 77.00	$1,596.46	$30.39	$1.54	$31.93
250	1,519.46	385.00	1,904.46	6.08	1.54	7.62
500	1,519.46	770.00	2,289.46	3.04	1.54	4.58
750	1,519.46	1,155.00	2,674.46	2.03	1.54	3.57
1,000	1,519.46	1,540.00	3,059.46	1.52	1.54	3.06

Large Loose Hay Stacking Wagon System

With this system the hay was cut with a self-propelled swather. The hay was harvested with a loose hay stacking wagon. The stacking wagon picks up the swathed hay and blows it into a wagon where it is compressed into a tight six-ton, loose haystack. The stacking wagon hauls the hay to an area to be unloaded and stored until fed. One worker was required for this hay harvesting system.

The machinery required for this hay harvesting system is:

Swather: 16' self-propelled
Stacking wagon: Six-ton stacks
Tractor: 80-95 horsepower, used at 75 percent load

The total allocated investment for this hay harvesting system was $15,493.90.

The costs for this system were:

Fixed Costs:

Shelter and Insurance	$ 154.94
Depreciation	1,378.69
Interest	681.73
Total Fixed Costs	$2,215.36

Variable Costs Per Ton:

Swather:		
Labor	.26	
Gas	.14	
Lubrication	.02	
Repairs	.06	$ .48
Tractor and Stacking Wagon:		
Labor	.24	
Fuel	.23	
Lubrication	.03	
Repairs	.49	.99
Total Variable Costs Per Ton		$ 1.47

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 10.

TABLE 10. COSTS FOR LARGE LOOSE HAY STACKING WAGON HARVESTING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$2,215.36	$ 73.50	$2,288.86	$44.31	$1.47	$45.78
250	2,215.36	367.50	2,582.86	8.86	1.47	10.33
500	2,215.36	735.00	2,950.36	4.43	1.47	5.90
750	2,215.36	1,102.50	3,317.86	2.95	1.47	4.42
1,000	2,215.36	1,470.00	3,685.36	2.22	1.47	3.67

Loader Loose Hay Stacking System

With this system the hay is cut with a self-propelled swather. The hay is bucked into stacks in a stackframe by means of a loader with a pushoff. The loose haystacks are moved later by a stackmover to the feeding area. The stacks are custom moved at a rate of $1.50 per ton. One worker was required for this hay harvesting system.

The machinery required for this hay harvesting system is:

Swather: 14' self-propelled
Stackframe: Medium size
Tractor: 60-75 horsepower, used at 50 percent load
Loader with pushoff: Medium size

The total allocated investment for this hay harvesting system was $4,270.15.

The costs for this system were:

Fixed Costs:

Shelter and Insurance		$ 42.70
Depreciation		419.02
Interest		187.89
	Total Fixed Costs	$ 649.61

Variable Costs Per Ton:

Swather:			
Labor	.36		
Gas	.14		
Lubrication	.02		
Repairs	.08	$	.60
Tractor with Loader and Stack Frame:			
Labor	.50		
Fuel	.28		
Lubrication	.04		
Repairs	.13		.95
Stack Moving One Ton of Hay:			1.50
	Total Variable Costs Per Ton	$	3.05

The costs of harvesting hay with this system for different tonnages harvested annually are presented in Table 11.

TABLE 11. COSTS FOR LOADER LOOSE HAY STACKING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$649.61	$ 152.50	$ 802.11	$12.99	$3.05	$16.04
250	649.61	762.50	1,412.11	2.60	3.05	5.65
500	649.61	1,525.00	2,174.61	1.30	3.05	4.35
750	649.61	2,287.50	2,937.11	.87	3.05	3.92
1,000	649.61	3,050.00	3,699.61	.65	3.05	3.70

HAY FEEDING COSTS

The costs of harvesting hay and getting it to the storage area are not the complete costs of haying. The costs of hay feeding are also a concern to the farmer. When a hay harvesting system is selected, the costs of feeding hay associated with a particular system cannot be ignored. Often the feeding costs are forgotten because they are not too large and the investment involved is small compared to the amount invested in the harvesting system. It is important to match the farmer's variable and fixed resources for hay feeding just as it is for hay harvesting. The decision to invest in a hay harvesting system may depend upon the additional investment for feeding machinery and equipment, labor required, or the capacity of the feeding system. A large number of hay feeding systems or variations of systems are available. The

more simple and less expensive systems of feeding were considered for this study. These feeding systems are slightly labor intensive, have a small capacity, but also required a relatively small investment.

The tractor used to feed hay has allocated at a rate of 13.5 percent of its value to hay feeding. A hay harvesting system that did not use a loader was charged for the complete value of the loader if one was necessary for feeding. If a harvesting system required a loader, that portion not allocated to hay harvesting was allocated to hay feeding. Feed wagons used for the hay chopping system were charged completely to hay harvesting. No allocation of the feedwagon was made to hay feeding because it is not required in all hay-lage feeding operations.

Feeding System for Baled Hay

With this feeding system the bales are loaded by hand from the stack to a loader mounted on a tractor. The bales are then hauled to a hayrack where the twine strings were cut and the hay dropped into the rack. The hay is self-fed to the cattle with this system. One worker was necessary to feed hay with this system.

The machinery and equipment required for this hay feeding system are:

Tractor: 40-55 horsepower, used at 50 percent load
Loader: Hydraulic, with bucket
Hayrack: 16', metal, four-ton capacity

The allocated investment for this feeding system when the harvesting system has no loader is $2,453.40. If a loader is required for the harvesting system, the allocated investment is $1,515.90.

The total annual fixed costs for the hay feeding system with no loader for hay harvesting was $403.47, while only $247.38 with the harvesting system which required a loader. The total variable cost per ton was $1.61 for all baled hay feeding systems.

Big Bale Feeding System

With this feeding system one big bale is fed at a time. The bales are carried with a loader mounted on a tractor from the place where they were stored to where they are to be fed. The bale is dumped into a hayrack after the twine is cut. The hay is self-fed with this feeding system by allowing the cattle to unwind the bale as they are eating it. One worker was required to feed hay with this system.

The machinery and equipment required for this hay feeding system are:

Tractor: 40-55 horsepower, used at 50 percent load
Loader: Hydraulic, with bucket
Hayrack: Wood, one big bale capacity

The total allocated investment for this hay feeding system was $2,203.40.

The total annual fixed cost for this system was $366.86. The total variable cost per ton fed was $.64.

Haylage Feeding System

With this feeding system the chopped hay was removed from the haylage pile by means of a loader mounted on a tractor. The haylage is loaded into a feed wagon and hauled to where it is to be fed. The haylage is unloaded into feed bunks for the cattle to eat. Only the amount of haylage the cattle can eat is fed to prevent excess wastes. One worker was required to feed hay with this system.

The machinery and equipment required for this hay feeding system are:

Tractor: 40-55 horsepower, used at 50 percent load
Loader: Hydraulic, with bucket
Feed wagon: Medium size, self-unloading
Feed bunk: 16', wood

The total allocated investment for the hay feeding system was $2,413.40.

The total annual fixed cost for this hay feeding system was $426.12 A $1.18 variable cost per ton was incurred in using this feeding system.

Loose Hay Feeding System

With this feeding system the hay is removed from the loose haystack with a grapple fork on a loader. The hay is then hauled from the stack to a feed rack where it is dropped into the feed rack. The hay is self-fed to the cattle with this system. One worker was required to feed hay with this system.

The machinery and equipment for this hay feeding system are:

Tractor: 40-55 horsepower, used at 50 percent load
Loader: Hydraulic
Grapple fork: Hydraulic
Hayrack: 16', metal, four-ton capacity

The total allocated investment for this hay feeding system was $2,753.40.

The total annual fixed costs for this hay feeding system were $453.43. A variable cost of $.82 per ton was incurred in using this feeding system.

HAY LOSSES

The amount of hay lost due to weather or storage losses, along with the amount of hay wasted by cattle after they have been fed (or feeding losses), are considered part of total haying costs. Hay losses are expressed as a percentage of total hay. Losses due to storage are given as a percentage of total hay fed. Storage losses are given for all types of hay harvested.

Feeding losses are given for all types of hay except haylage, which is not considered to have a significant feeding loss (Table 12).

TABLE 12. STORAGE AND FEEDING LOSSES FOR DIFFERENT HAY SYSTEMS, 1973

Type of Hay	Storage Loss[a]	Feeding Loss[b]
	percent of hay harvested	percent of hay fed
Loose Hay (loader-stacker)	3.5	2.34
Bales	4.5	4.00
Big Bales	3.5	4.40
Loose Hay (stacking wagon)	3.5	2.34
Haylage	12.5	--

[a]Stevens, Delwin M., and Don R. Hanson, Hay Harvesting, Storing, and Feeding Methods in Wyoming--An Economic Analysis, Bulletin 590, Department of Agricultural Economics, Agricultural Experiment Station, University of Wyoming, Laramie, Wyoming, July, 1973.

[b]Smith, Bill, Vic Lechtenberg, Sam Persons, and Dave Petritz, Storing and Feeding Big Hay Packages for Beef Cattle, Departments of Animal Science, Agronomy, Agricultural Engineering, and Agricultural Economics, Agricultural Experiment Station, Purdue University, West Lafayette, Indiana, January, 1973.

In order to consider hay losses, the loss percentages must be converted to a dollar value. This is done by multiplying the percentage loss by the value of a ton of hay to arrive at a dollar loss per ton. For this study a value of $30.00 per ton was used for tame hay. The dollar costs of hay losses are added to hay harvesting and hay feeding costs do obtain the total costs of haying.

TOTAL HAYING COSTS

Total costs of haying are very important to the farmer who raises livestock. To arrive at total cost, each hay harvesting system was matched to a complementary hay feeding system. The total annual fixed costs of hay harvesting and hay feeding are added together to obtain total annual fixed costs for a complete haying system. By adding the variable cost per ton for hay harvesting and hay feeding and storage and feeding losses per ton, the variable cost per ton for a complete haying system is found. After these two costs are found, the rest of the costs associated with each complete haying system are easily calculated.

Baling and Manually Stacking Bales

The baling and manually stacking bales system was matched with the baled hay feeding system to make a complete haying system. Adding the fixed costs of $798.92 (Table 1) for hay harvesting and $403.47 for hay feeding gives a $1,202.39 total fixed cost for the complete haying system. The variable cost per ton of $12.83 is calculated by adding the $8.67 variable cost for hay harvesting, the $1.61 hay feeding variable cost, and the $2.55 hay losses. The total annual costs and the costs per ton for this haying system are presented in Table 13.

TABLE 13. COSTS FOR BALING AND MANUALLY STACKING BALES WITH BALED HAY FEEDING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$1,202.39	$ 641.50	$ 1,843.89	$24.04	$12.83	$36.88
250	1,202.39	3,207.50	4,409.89	4.81	12.83	17.64
500	1,202.39	6,415.00	7,617.39	2.41	12.83	15.23
750	1,202.39	9,622.50	10,824.89	1.60	12.83	14.43
1,000	1,202.39	12,830.00	14,032.39	1.20	12.83	14.03

Bale Accumulator System

The bale accumulator harvesting system is paired with a baled hay feeding system to arrive at a complete haying system. The costs for the complete haying system are calculated as previously explained. The total annual costs and the costs per ton for this complete haying system are given in Table 14.

TABLE 14. COSTS FOR BALE ACCUMULATOR SYSTEM WITH BALED HAY FEEDING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$1,643.83	$ 360.00	$2,003.83	$32.88	$7.20	$40.08
250	1,643.83	1,800.00	3,443.83	6.58	7.20	13.78
500	1,643.83	3,600.00	5,243.83	3.29	7.20	10.49
750	1,643.83	5,400.00	7,043.83	2.19	7.20	9.39
1,000	1,643.83	7,200.00	8,843.83	1.64	7.20	8.84

Small Automatic Bale Wagon System

The small automatic bale wagon system is paired with a baled hay feeding system to make a complete haying system. The total annual costs and the costs per ton for this complete haying system are given in Table 15.

TABLE 15. COSTS FOR SMALL AUTOMATIC BALE WAGON SYSTEMS WITH BALED HAY FEEDING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$1,949.11	$ 339.00	$2,288.11	$38.98	$6.78	$45.76
250	1.949.11	1,695.00	3,644.11	7.80	6.78	14.58
500	1,949.11	3,390.00	5,339.11	3.90	6.78	10.68
750	1,949.11	5,085.00	7,007.11	2.60	6.78	9.34
1,000	1,949.11	6,780.00	8,729.11	1.95	6.78	8.73

Large Automatic Bale Wagon System

The large automatic bale wagon system is matched with a baled hay feeding system to make a complete haying system. The total annual costs and the costs per ton for this complete haying system are presented in Table 16.

TABLE 16. COSTS FOR LARGE AUTOMATIC BALE WAGON SYSTEM WITH BALED HAY FEEDING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$2,325.85	$ 332.50	$2,658.35	$46.52	$6.65	$53.17
250	2,325.85	1,662.50	3,988.35	9.30	6.65	15.95
500	2,325.85	3,325.00	5,650.85	4.65	6.65	11.30
750	2,325.85	4,987.50	7,313.35	3.10	6.65	9.75
1,000	2,325.85	6,650.00	8,975.85	2.33	6.65	8.98

Small Big Baler System

The small big baler system is paired with a big bale feeding system to arrive at a complete haying system. The total annual costs and the costs per ton for this complete haying system are given in Table 17.

TABLE 17. COSTS FOR SMALL BIG BALE HARVESTING AND FEEDING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$1,344.33	$ 267.00	$1,611.33	$26.89	$5.34	$32.27
250	1,344.33	1,335.00	2,679.33	5.38	5.34	10.72
500	1,344.33	2,670.00	4,014.33	2.69	5.34	8.03
750	1,344.33	4,005.00	5,349.33	1.79	5.34	7.13
1,000	1,344.33	5,340.00	6,684.33	1.34	5.34	6.68

Large Big Bale System

The large big bale system is paired with a big bale feeding system to make a complete haying system. The total annual costs and the costs per ton for this complete haying system are presented in Table 18.

TABLE 18. COSTS FOR LARGE BIG BALE HARVESTING AND FEEDING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$1,612.37	$ 247.50	$1,859.87	$32.25	$4.95	$37.20
250	1,612.37	1,237.50	2,849.87	6.45	4.95	11.40
500	1,612.37	2,475.00	4,087.37	3.22	4.95	8.18
750	1,612.37	3,712.50	5,324.87	2.15	4.95	7.10
1,000	1,612.37	4,950.00	6,562.37	1.61	4.95	6.56

Small Hay Chopping System

The small hay chopping system was paired with a haylage feeding system to arrive at a complete haying system. The total annual costs and the costs per ton for this complete haying system are presented in Table 19.

TABLE 19. COSTS FOR SMALL HAY CHOPPING SYSTEM WITH HAYLAGE FEEDING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$2,083.77	$ 343.50	$2,427.27	$41.68	$6.87	$48.55
250	2,083.77	1,717.50	3,801.27	8.34	6.87	15.21
500	2,083.77	3,435.00	5,518.77	4.17	6.87	11.04
750	2,083.77	5,152.50	7,236.27	2.78	6.87	9.65
1,000	2,083.77	6,870.00	8,953.77	2.08	6.87	8.95

Large Hay Chopping System

The large hay chopping system was matched with a haylage feeding system to make a complete haying system. The total annual costs and the costs per ton for this complete haying system are given in Table 20.

TABLE 20. COSTS FOR LARGE HAY CHOPPING SYSTEM WITH HAYLAGE FEEDING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$2,478.69	$ 328.00	$2,806.69	$49.57	$6.56	$56.13
250	2,478.69	1,640.00	4,118.69	9.91	6.56	16.48
500	2,478.69	3,280.00	5,758.69	4.96	6.56	11.52
750	2,478.69	4,920.00	7,398.69	3.31	6.56	9.87
1,000	2,478.69	6,560.00	9,038.69	2.48	6.56	9.04

Small Loose Hay Stacking Wagon System

The small loose hay stacking wagon system is paired with a loose hay feeding system to make a complete haying system. The total annual costs and costs per ton are presented in Table 21.

TABLE 21. COSTS FOR SMALL LOOSE HAY STACKING WAGON SYSTEM WITH LOOSE HAY FEEDING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$1,972.89	$ 205.50	$2,178.39	$39.46	$4.11	$43.57
250	1,972.89	1,027.50	3,000.39	7.89	4.11	12.00
500	1,972.89	2,055.00	4,027.89	3.95	4.11	8.06
750	1,972.89	3,082.50	5,055.39	2.63	4.11	6.74
1,000	1,972.89	4,110.00	6,082.89	1.97	4.11	6.08

Large Loose Hay Stacking Wagon System

The large loose hay stacking wagon is matched with a loose hay feeding system to make a complete haying system. The total annual costs and the costs per ton are presented in Table 22.

TABLE 22. COSTS FOR LARGE LOOSE HAY STACKING WAGON SYSTEM WITH LOOSE HAY FEEDING SYSTEM, 1973

	Total Annual Costs			Costs Per Ton		
Tons	TFC	TVC	TC	AFC	AVC	ATC
50	$2,668.79	$ 202.00	$2,870.79	$53.38	$4.04	$57.42
250	2,668.79	1,010.00	3,678.79	10.68	4.04	14.72
500	2,668.79	2,020.00	4,688.79	5.34	4.04	9.38
750	2,668.79	3,030.00	5,698.79	3.56	4.04	7.60
1,000	2,668.79	4,040.00	6,708.79	2.67	4.04	6.71

Loader Loose Hay Stacking System

The loader loose hay stacking system was paired with a loose hay feeding system to make a complete haying system. The total annual costs and the costs per ton for this complete haying system are given in Table 23.

Haying System Groups

The 11 haying systems considered in this study can be placed into three groups. Group 1 contains those haying systems which are used for rather small tonnages annually. Group 1 contains baling and manually stacking bales, bale accumulator system, and loader loose hay stacking system. Group 2 has those

TABLE 23. COSTS FOR LOADER LOOSE HAY STACKING SYSTEM WITH LOOSE HAY FEEDING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	$1,103.04	$ 281.00	$1,384.04	$22.06	$5.62	$27.68
250	1,103.04	1,405.00	2,508.04	4.41	5.62	10.03
500	1,103.04	2,810.00	3,913.04	2.21	5.62	7.83
750	1,103.04	4,215.00	5,318.04	1.47	5.62	7.09
1,000	1,103.04	5,620.00	6,723.04	1.10	5.62	6.72

systems for medium tonnages harvested and fed annually. Group 2 contains a small automatic bale wagon system, small big baler system, small hay chopping system, and small loose hay stacking wagon system. Group 3 is the system for very large tonnages of hay harvested and fed annually. Group 3 contains a large automatic bale wagon system, large big baler system, large hay chopping system, and large loose hay stacking wagon system. The cost curves for Groups 1, 2, and 3 haying systems are shown in Figures 1, 2, and 3, respectively.

CONCLUSIONS

Economies do exist for total haying systems. Each of the three groups of haying systems has a system which realizes lower costs per ton harvested and fed annually.

In Group 1 the loader loose hay stacking system has the lowest total haying costs for all tonnages harvested and fed annually. Group 2 has two systems which are the least cost. The small big baler system is least cost for all tonnages up to 500 tons harvested and fed annually. Beyond 500 tons annually, the small loose hay stacking wagon has the lowest total cost. Within this medium tonnages harvested and fed annually group, if smaller tonnages are desired, the small big baler system is most economical. If more tons are to be harvested and fed annually, the small loose hay stacking wagon is most economical. The large big baler system is the least-cost system in Group 3 for all tonnages harvested and fed annually. This system is for a very large number of tons harvested annually.

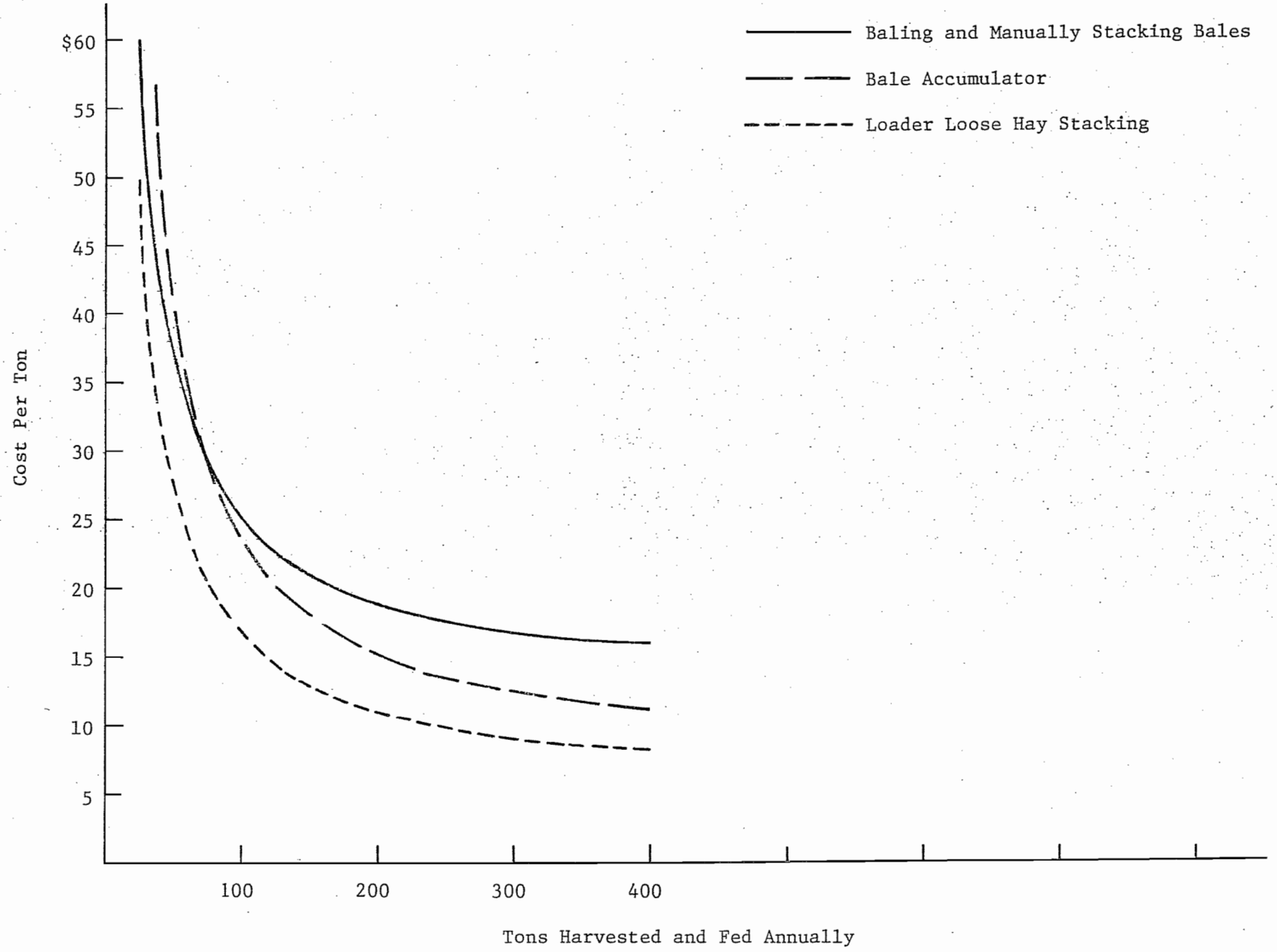

Figure 1. Cost Per Ton of Hay Harvested and Fed Annually for Group I Haying Systems

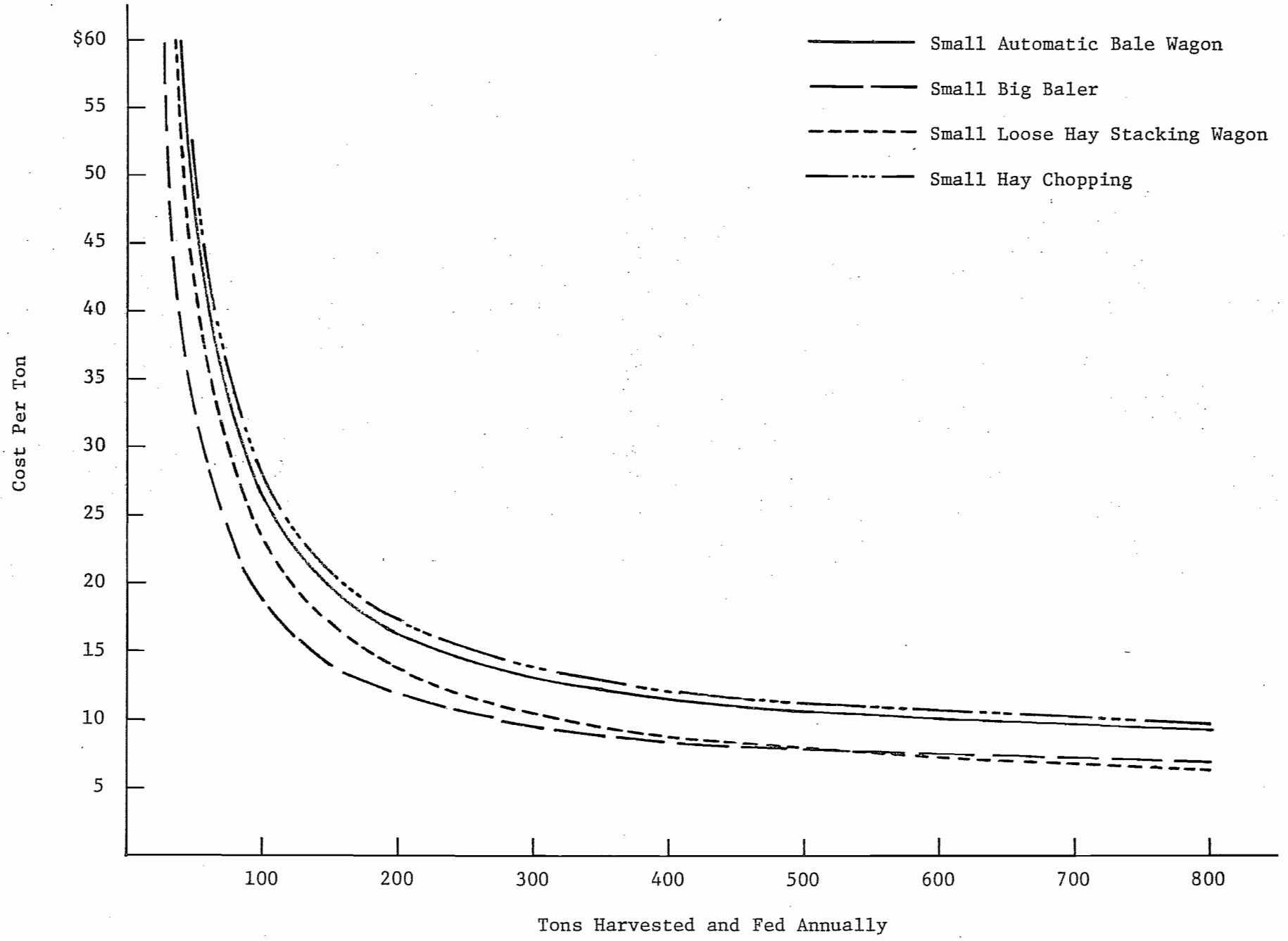

Figure 2. Cost Per Ton of Hay Harvested and Fed Annually for Group II Haying Systems.

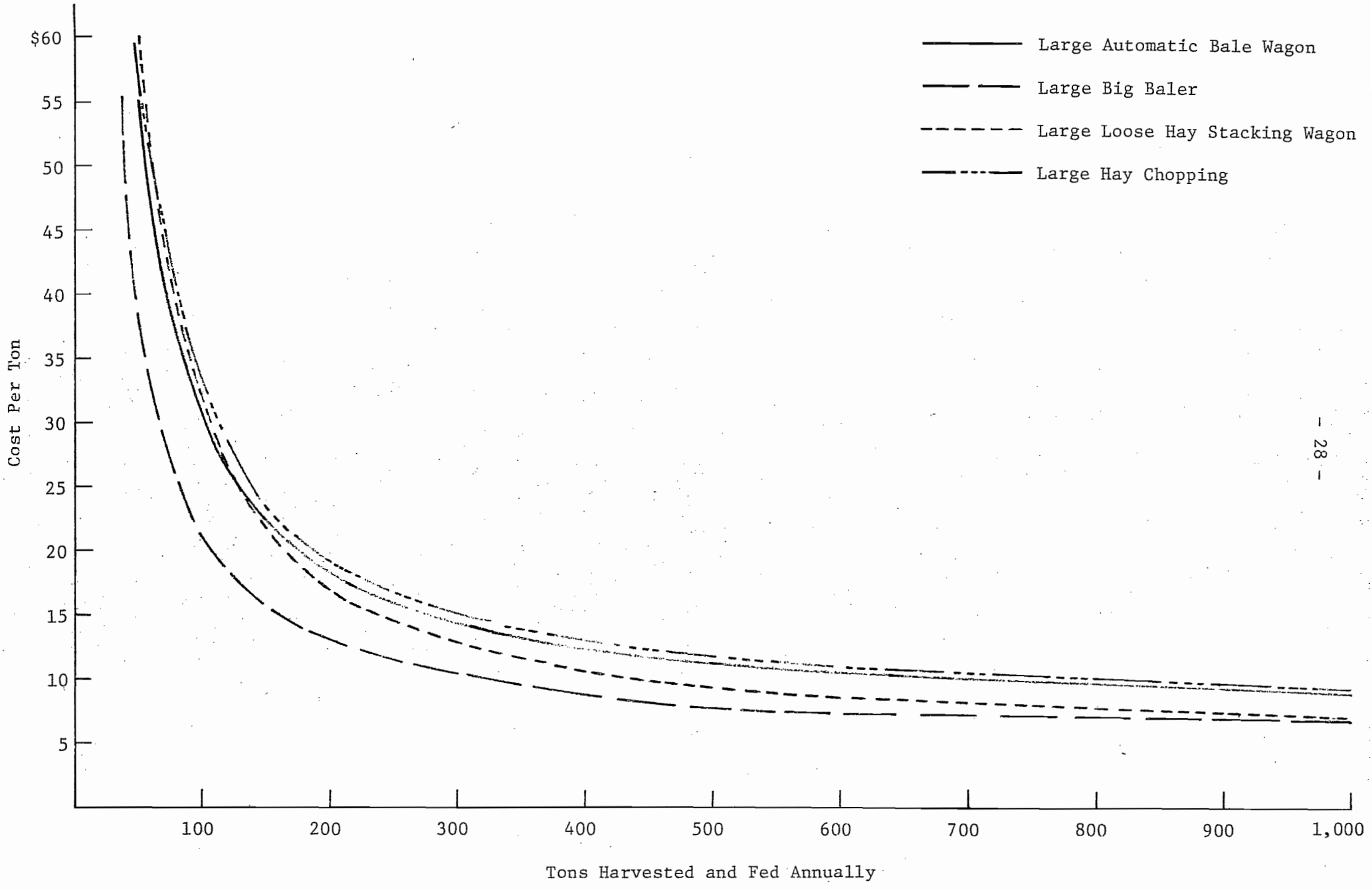

Figure 3. Cost per ton of hay harvested and fed annually for Group III haying systems.

APPENDIX

APPENDIX TABLE 1. FUEL CONSUMPTION PER HOUR UNDER VARIOUS PERCENTAGE LOADS

Tractor HP Group	Number in Sample	Average HP	100 Percent Load	75 Percent Load	50 Percent Load
			gal./hr.	gal./hr.	
40-55 HP Diesel	15	48.065	3.212	2.721	2.198
60-75 HP Diesel	14	65.266	4.455	3.713	2.972
80-95 HP Diesel	11	89.062	6.010	5.124	4.245
95-120 HP Diesel	12	112.208	7.321	6.377	5.126

Source: American Society of Agricultural Engineers, "Nebraska Tractor Test Data," Agricultural Engineering Yearbook, 1973, pp. 521-529.

APPENDIX TABLE 2. REPAIR AND MAINTENANCE COST PER HOUR, PERCENTAGE OF PURCHASE PRICE

Machine	Percent of New Price for 100 Hours' Use	Percent of New Price for One Hour's Use
	percent	
Swather	4.0	.04
Mower	12.0	.12
Rake	7.0	.07
Baler	3.1	.031
Wagon	1.8	.018
Bale Accumulator	2.5	.025
Big Baler	3.1	.031
Big Bale Carrier	.50	.005
Automatic Bale Wagon	3.0	.03
Forage Harvester	2.9	.029
Forage Wagons	1.8	.018
Stacking Wagon	3.0	.03
Stack Frame	1.0	.01
Loader with Pushoff	2.0	.02
Tractor	1.0	.01

Source: Hunt, Donnell, Farm Power and Machinery Management, Sixth Edition, Department of Agricultural Engineering, University of Illinois, Urbana, Illinois, 1973.

APPENDIX TABLE 3. FUEL AND LUBRICATION COSTS PER HOUR FOR VARIOUS HORSEPOWER GROUPS OF TRACTORS UNDER DIFFERENT PERCENTAGE LOADS, AND SWATHER FUEL AND LUBRICATION COSTS, MAY, 1974

Machine	Horsepower Group	Percentage Load	Gallons Per Hour	Fuel Price (gas or diesel)	Fuel Cost Per Hour	Lubrication Cost Per Hour
		percent				
Tractor, Diesel	40-55 HP	100	3.212	.370	1.19	.18
Tractor, Diesel	40-55 HP	75	2.721	.370	1.01	.15
Tractor, Diesel	40-55 HP	50	2.198	.370	.81	.12
Tractor, Diesel	60-75 HP	100	4.455	.370	1.65	.25
Tractor, Diesel	60-75 HP	75	3.713	.370	1.37	.21
Tractor, Diesel	60-75 HP	50	2.972	.370	1.10	.17
Tractor, Diesel	80-95 HP	100	6.010	.370	2.22	.33
Tractor, Diesel	80-95 HP	75	5.124	.370	1.90	.28
Tractor, Diesel	80-95 HP	50	4.245	.370	1.51	.24
Tractor, Diesel	95-120 HP	100	7.321	.370	2.71	.41
Tractor, Diesel	95-120 HP	75	6.377	.370	2.36	.35
Tractor, Diesel	95-120 HP	50	5.126	.370	1.90	.29
Swather, Gas	14' SP		1.94	.400	.78	.12
Swather, Gas	16' SP		2.72	.400	1.09	.16

Source: Fuel prices were from a survey of local bulk dealers, May, 1974.

APPENDIX TABLE 4. LIST PRICES OF MACHINERY USED FOR HAY HARVESTING, 1973

Machine	Description	List Price
Tractor	40-55 HP Diesel	$ 6,180
Tractor	60-75 HP Diesel	7,390
Tractor	80-95 HP Diesel	10,140
Tractor	95-120 HP Diesel	11,910
Swather	14-15' Self-Propelled	4,370
Swather	16-18' Self-Propelled	4,500
Mower	9' Pull-Type	860
Rake	9' Side Delivery	930
Baler	PTO, Twine, Medium Size	3,020
Baler	PTO, Twine, Large Size	3,870
Automatic Bale Wagon	Pull-Type, Medium Size	5,000
Automatic Bale Wagon	Pull-Type, Large Size	6,500
Big Baler	Pull-Type, 1,500#	3,960
Big Baler	Pull-Type, 2,500#	5,490
Stacking Wagon	3 Ton (hesston)	8,500
Stacking Wagon	6 Ton (hesston)	13,000
Forage Harvester	PTO, Medium Size	3,700
Forage Harvester	PTO, Large Size	4,430
Forage Wagon	Medium Size	2,000
Forage Wagon	Large Size	2,900
Bale Accumulator	Eight Bale	1,580
Bale Accumulator Fork		500
Front End Loader	Hydraulic	1,250
Wagon		600
Big Bale Carrier		865
Stack Frame		400
Loader with Pushoff		1,780
Grapple Fork	Hydraulic	300
Feed bunk	16' (¼ ton capacity)	90
Hayrack	Metal (4 ton capacity)	400
Big Bale Hayrack	One Big Bale Capacity	150

Source: Survey of Farm Machinery Dealerships in Cass County, prices are list prices with standard equipment, November, 1973.

APPENDIX TABLE 5. MACHINERY CAPACITIES AND LABOR REQUIREMENTS FOR HAY HARVESTING MACHINERY

Machine	Capacity	Labor Requirement
Swather, 14'	5.7 acres/hour	.18 man-hours/ton
Swather, 16'	8.0 acres/hour	.13 man-hours/ton
Mower, 9'	3.7 acres/hour	.27 man-hours/ton
Rake, 9'	5.2 acres/hour	.19 man-hours/ton
Baler, Medium, PTO	6.4 tons/hour	.16 man-hours/ton
Baler, Large, PTO	8.0 tons/hour	.13 man-hours/ton
Automatic Bale Wagon, Medium, PTO	6.5 tons/hour	.15 man-hours/ton
Automatic Bale Wagon, Large, PTO	8.0 tons/hour	.13 man-hours/ton
Big Baler, Medium	6.0 tons/hour	.17 man-hours/ton
Big Baler, Large	7.5 tons/hour	.13 man-hours/ton
Stacking Wagon, 3 Ton	6.5 tons/hour	.15 man-hours/ton
Stacking Wagon, 6 Ton	8.5 tons/hour	.12 man-hours/ton
Forage Harvester, Medium, PTO	9.0 tons/hour	.11 man-hours/ton
Forage Harvester, Large, PTO	11.0 tons/hour	.09 man-hours/ton
Hydraulic Loader, Stacker, and Frame	4.0 tons/hour	.25 man-hours/ton
Three Men Hauling and Stacking Bales	2.7 tons/hour	1.11 man-hours/ton

(Capacities based on assumption of one ton per acre average yield)

Source: Rider, Allen, and Wendell Bowers, Cost, Capacity, and Management of Oklahoma Hay Systems, Department of Agricultural Engineering, Agricultural Experiment Station, University of Oklahoma, Stillwater, Oklahoma, 1972.

APPENDIX TABLE 6. NUMBER OF LABORERS AND HOURS OF LABOR REQUIRED PER TON HARVESTED FOR TAME HAY HARVESTING SYSTEMS

System	Number of Laborers	Hours Per Ton Harvested
Baling and Manually Stacking Bales	3	1.45
Bale Accumulator	2	.65
Small Automatic Bale Wagon	2	.49
Large Automatic Bale Wagon	2	.39
Small Big Baler	1	.57
Large Big Baler	1	.39
Small Hay Chopping	3	.51
Large Hay Chopping	3	.40
Small Loose Hay Stacking Wagon	1	.33
Large Loose Hay Stacking Wagon	1	.25
Loader Loose Hay Stacking Wagon	1	.43