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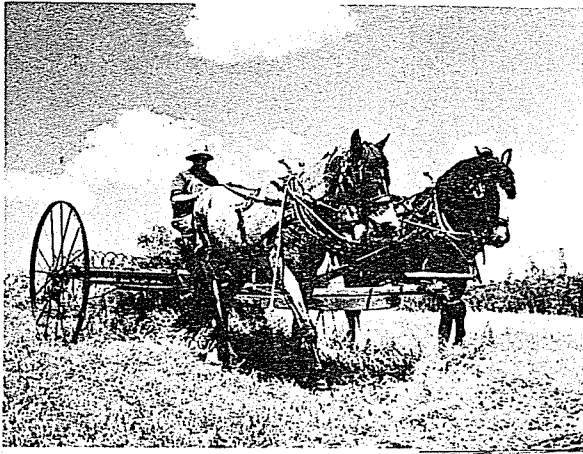
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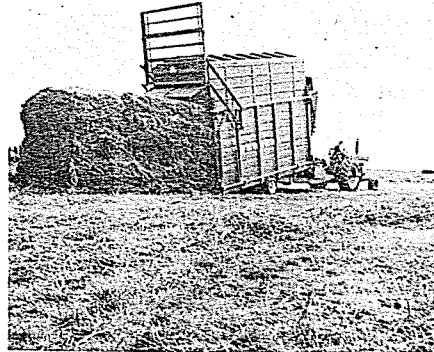
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**Costs
of Native**



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 native hay. A separate report has been prepared for tame haying costs. The intent of this report is to provide information to farmers and ranchers helpful 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. Prof. LeRoy W. Schaffner, Dr. Robert D. Carver, and Dr. Roger G. Johnson provided assistance from the beginning of this study.

TABLE OF CONTENTS

	<u>Page</u>
Highlights	ii
Procedure	1
Hay Harvesting Costs	1
Baling and Manually Stacking Bales	2
Bale Accumulator System	3
Small Automatic Bale Wagon System	5
Large Automatic Bale Wagon System	6
Small Big Bale System	7
Large Big Bale System	9
Small Loose Hay Stacking Wagon System	10
Large Loose Hay Stacking Wagon System	12
Loader Loose Hay Stacking System	13
Hay Feeding Costs	15
Feeding System for Baled Hay	15
Big Bale Feeding System	15
Loose Hay Feeding System	15
Hay Losses	16
Total Haying Costs	17
Baling and Manually Stacking Bales	17
Bale Accumulator System	17
Small Automatic Bale Wagon System	17
Large Automatic Bale Wagon System	18
Small Big Bale System	18
Large Big Bale System	19
Small Loose Hay Stacking Wagon System	19
Large Loose Hay Stacking Wagon System	20
Loader Loose Hay Stacking System	20
Conclusions	24

Highlights

The purpose of this study was to provide information useful in decision making to farmers and ranchers producing native hay. This report on native hay is to be supplemental to Agricultural Economics Report No. 97 on tame hay harvesting and feeding costs. 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 the technique used to arrive at the costs for each system.

Nine hay harvesting systems were considered for 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.

Three hay feeding systems were combined with the nine harvesting systems. The hay feeding systems were: standard size baled hay, big bale, and loose hay.

Hay losses are also expensive 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 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 annual fixed costs. 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 the costs per ton can be figured.

Group 1 contains the baling and manually stacking bales, bale accumulator, and loose hay stacking systems. In this group the loader loose hay stacking system had the lowest cost per ton native hay total haying costs. This group was for up to 400 tons harvested and fed annually. Group 2 contains the small automatic bale wagon, small big baler, and small loose hay stacking wagon systems. The small big baler had the lowest cost per ton total haying costs with up to 550 tons harvested and fed annually. Beyond 550 tons harvested and fed annually, the small loose hay stacking wagon had the lowest total haying costs for native hay. Group 2 haying systems are for annual tonnages harvested and fed up to 800. Group 3 contains the large automatic bale wagon, large big baler, and large loose hay stacking wagon systems. In this group the large big baler had the lowest cost per ton total haying costs. Group 3 systems were for up to 1,000 tons harvested and fed annually.

COSTS OF NATIVE HAY HARVESTING SYSTEMS IN NORTH DAKOTA

by
Randal C. Coon and F. Larry Leistritz*

The purpose of this report is to provide information on native haying costs for North Dakota farmers and ranchers.¹ A previous report presented costs for tame hay harvesting and feeding systems.² The native hay harvesting systems assume the use of a mower and rake to cut hay; whereas, the tame hay systems assumed use of a swather. The rest of the harvesting system was the same for native hay as for tame. The feeding systems for tame and native hay were identical. Storage and feeding loss costs per ton for native hay were different from those of tame hay because the prices per ton of native hay were less than tame hay. Nine native hay harvesting systems were analyzed compared to the eleven used for harvesting tame hay.

Procedure

The procedures followed for native hay systems were parallel to those used for tame hay systems. A yield of one ton per acre was assumed to be attained from one cutting. All assumptions concerning costs, capacities, calculating formulas, and theoretical concepts used for this report were the same as those in Agricultural Economics Report No. 97. For complete details on these matters, consult Agricultural Economics Report No. 97.

Hay Harvesting Costs

Nine systems of harvesting native hay were used to analyze the costs of harvesting different tonnages of hay annually. The systems considered are as follows: baling and manually stacking bales, bale accumulator, loader loose hay stacking, small and large automatic bale wagon, small and large big bale, and small and large loose hay stacking wagon. The total annual cost and the costs per ton were calculated for each of the systems and are presented in table form.

*Coon is Research Assistant and Leistritz is Associate Professor, Department of Agricultural Economics, North Dakota State University, Fargo.

¹For purposes of this report, tame hay is defined as grass and legume species planted specifically for hay production and native hay is defined as all native vegetation utilized for hay production.

²Coon, Randal C., and F. Larry Leistritz, An Economic Analysis of Hay Harvesting Systems in North Dakota, Agricultural Economics Report No. 97, Department of Agricultural Economics, North Dakota State University, Fargo, August, 1974.

Baling and Manually Stacking Bales

The hay is cut with a mower and later raked into windrows. 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 are unloaded and stacked by the 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:

- Mower: 9' pull-type
- Rake: 9' side delivery
- Baler: power-take-off, twine-tie, medium size
- Wagon: 12' flatbed
- 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 \$6,316.90.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 63.17
Depreciation	496.46
Interest	<u>277.94</u>
TOTAL FIXED COSTS	\$837.57

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

Tractor and Baler:

Labor	.32	
Fuel	.22	
Lubrication	.03	
Repairs	.16	
Twine	.60	\$ 1.33

Three Men Stacking Hay on a Wagon and Unloading:

Labor	\$6.66	
Repairs	.07	\$ 6.73

TOTAL VARIABLE COSTS PER TON \$ 9.84

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

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

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$837.57	\$ 492.00	\$ 1,329.57	\$16.75	\$9.84	\$26.59
250	837.57	2,460.00	3,297.57	3.35	9.84	13.19
500	837.57	4,920.00	5,757.57	1.68	9.84	11.52
750	837.57	7,380.00	8,217.57	1.12	9.84	10.96
1,000	837.57	9,840.00	10,667.57	.84	9.84	10.68

Bale Accumulator System

The hay harvested with this system is cut with a mower and later raked into windrows. The smaller tractor is used to pull the mower and rake. The hay is harvested by pulling a baler and bale accumulator with the larger tractor. The accumulator drops the bales in groups of eight, which are picked up with a special fork in the tractor-mounted loader. The bales are loaded on a wagon, hauled to a storage area, and then unloaded and stacked 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:

Mower: 9' pull-type
 Rake: 9' side delivery
 Baler: power-take-off, twine-tie, medium size
 Bale accumulator: eight-bale type
 Wagon: 12' flatbed
 Tractor: 60-75 horsepower, used at 75 percent load
 Tractor, loader, and fork: 40-55 horsepower, used at 50 percent load

The total allocated investment for this hay harvesting system was \$10,259.45.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 95.62
Depreciation	891.44
Interest	451.42

TOTAL FIXED COSTS \$1,445.46

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

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 COST PER TON \$ 4.22

The costs of hay harvesting 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	\$1,445.46	\$ 211.00	\$1,656.46	\$28.91	\$4.22	\$33.13
250	1,445.46	1,055.00	2,500.46	5.78	4.22	10.00
500	1,445.46	2,110.00	3,555.46	2.89	4.22	7.11
750	1,445.46	3,165.00	4,610.46	1.93	4.22	6.15
1,000	1,445.46	4,220.00	5,665.46	1.45	4.22	5.67

Small Automatic Bale Wagon System

The hay is cut with a mower and later raked into windrows with this system. The smaller tractor was used on the mower and rake. The hay is harvested by baling and dropping the bales in the field and then picking up the bales and stacking them by means of an automatic bale wagon. The bales are then taken to an area where they are automatically unloaded and stacked for storage. Two workers were required for this hay harvesting system.

The hay harvesting machinery used in this system is:

Mower: 9' pull-type
Rake: 9' side delivery
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 costs for this system were:

Fixed Costs

Shelter and insurance	\$ 116.42
Depreciation	965.97
Interest	<u>512.25</u>
TOTAL FIXED COSTS	\$1,594.64

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

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 \$ 3.80

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 SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,594.64	\$ 190.00	\$1,784.64	\$31.89	\$3.80	\$35.69
250	1,594.64	950.00	2,544.64	6.38	3.80	10.18
500	1,594.64	1,900.00	3,494.64	3.19	3.80	6.99
750	1,594.64	2,850.00	4,444.64	2.13	3.80	5.93
1,000	1,594.64	3,800.00	5,394.64	1.59	3.80	5.40

Large Automatic Bale Wagon System

The hay is cut with a mower and later raked into windrows with this system. The smallest tractor is used on the mower and rake. The hay is baled and the bales are dropped on the ground. The largest tractor is used on the baler and the medium sized tractor on the automatic bale wagon. The bales are removed from the field by means of the automatic bale wagon and stacked where they are to be stored until fed. Two workers were required for this hay harvesting system.

The machinery required for harvesting hay with this system is:

- Mower: 9' pull-type
- Rake: 9' side delivery
- 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
- Tractor: 40-55 horsepower, used at 50 percent load

The allocated investment for this hay harvesting system was \$14,268.05.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 142.68
Depreciation	1,194.03
Interest	627.79
TOTAL FIXED COSTS	\$1,964.50

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

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 \$ 3.79

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 SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,964.50	\$ 189.50	\$2,154.00	\$39.29	\$3.79	\$43.08
250	1,964.50	947.50	2,912.00	9.82	3.79	11.65
500	1,964.50	1,895.00	3,895.50	3.93	3.79	7.72
750	1,964.50	2,842.50	4,807.00	2.69	3.79	6.41
1,000	1,964.50	3,790.00	5,754.50	1.96	3.79	5.76

Small Big Bale System

The hay is cut with a mower and later raked into windrows. The smaller tractor is used on the mower and rake. The hay is harvested with a big baler.

This baler makes 1,500-pound, large, round bales. The bales are moved to a location for storage (until feeding) by means of a big bale carrier. One worker was required for this hay feeding system.

The machinery used to harvest hay with this system is:

- Mower: 9' pull-type
- Rake: 9' side delivery
- Big baler: power-take-off, medium size, 1,500-pound bales
- Big bale carrier: carries one 1,500-pound bale
- 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 \$7,521.90.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 75.22
Depreciation	609.94
Interest	<u>330.96</u>
TOTAL FIXED COSTS	\$1,016.12

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

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 \$ 3.51

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

TABLE 5. COSTS FOR SMALL BIG BALER SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,016.12	\$ 175.50	\$1,191.62	\$20.32	\$3.51	\$23.83
250	1,016.12	877.50	1,893.62	4.06	3.51	7.57
500	1,016.12	1,755.00	2,771.12	2.03	3.51	5.54
750	1,016.12	2,632.50	3,648.52	1.35	3.51	4.87
1,000	1,016.12	3,510.00	4,526.12	1.02	3.51	4.53

Large Big Bale System

The hay is cut with a mower and later raked into windrows. The smaller tractor is used on the mower and rake. The hay is harvested with a big baler. The baler makes 2,500-pound, large, round bales. The bales are moved to a location for storage by means of a big bale carrier. One worker was required for this hay harvesting system.

The machinery required for harvesting hay with this system is:

- Mower: 9' pull-type
- Rake: 9' side delivery
- Big baler: power-take-off, large size, 2,500-pound bales
- Big bale carrier: carries one 2,500-pound bale
- Tractor: 80-95 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 \$9,197.10.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 91.97
Depreciation	756.35
Interest	403.88
TOTAL FIXED COSTS	\$1,252.20

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

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 \$ 3.24

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

TABLE 6. COSTS FOR LARGE BIG BALER SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,252.20	\$ 162.00	\$1,414.20	\$25.04	\$3.24	\$28.28
250	1,252.20	810.00	2,062.20	5.01	3.24	8.25
500	1,252.20	1,620.00	2,872.20	2.50	3.24	5.74
750	1,252.20	2,430.00	3,682.20	1.67	3.24	4.91
1,000	1,252.20	3,240.00	4,492.20	1.25	3.24	4.49

Small Loose Hay Stacking Wagon System

The hay is cut with a mower and later raked. The small tractor is used on the mower and rake. The hay is harvested with a loose hay stacking wagon.

The hay is blown into the stacking wagon and compressed to form a compact loose haystack. The hay is then hauled to an area to be unloaded and stored until it is to be fed. One worker was required for this hay harvesting system.

The machinery required for this hay harvesting system is:

- Mower: 9' pull-type
- Rake: 9' side delivery
- Stacking wagon: 3-ton stacks
- 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 \$11,196.90.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 111.97
Depreciation	953.66
Interest	<u>492.66</u>
TOTAL FIXED COSTS	\$1,558.29

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

Tractor and Stacking Wagon:

Labor	.30	
Fuel	.21	
Lubrication	.03	
Repairs	.40	<u>\$.94</u>

TOTAL VARIABLE COSTS PER TON \$ 2.72

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

TABLE 7. COSTS FOR SMALL LOOSE HAY STACKING WAGON SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,558.29	\$ 136.00	\$1,694.29	\$31.17	\$2.72	\$33.89
250	1,558.29	680.00	2,238.29	6.23	2.72	8.95
500	1,558.29	1,360.00	2,918.29	3.12	2.72	5.84
750	1,558.29	2,040.00	3,598.29	2.08	2.72	4.80
1,000	1,558.29	2,720.00	4,278.29	1.56	2.72	4.28

Large Loose Hay Stacking Wagon System

The hay is cut with a mower and later raked into windrows with this system. The small tractor is used on the mower and rake. The hay is harvested with a loose hay stacking wagon. The hay is blown into the wagon and compressed into a compact loose haystack. The hay is then 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:

- Mower: 9' pull-type
- Rake: 9' side delivery
- Stacking wagon: 6-ton stacks
- Tractor: 80-95 horsepower, used at 95 percent load
- Tractor: 40-55 horsepower, used at 50 percent load

The total allocated investment for this hay harvesting system was \$15,861.90.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 158.62
Depreciation	1,368.56
Interest	<u>697.95</u>
TOTAL FIXED COSTS	\$2,225.13

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	\$.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

Tractor and Stacking Wagon:

Labor	.24	
Fuel	.23	
Lubrication	.03	
Repairs	.49	\$.99

TOTAL VARIABLE COSTS PER TON \$ 2.77

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

TABLE 8. COSTS FOR LARGE LOOSE HAY STACKING WAGON SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$2,225.13	\$ 138.50	\$2,363.63	\$44.50	\$2.77	\$47.27
250	2,225.13	692.50	2,917.63	8.90	2.77	11.67
500	2,225.13	1,385.00	3,610.13	4.45	2.77	7.22
750	2,225.13	2,077.50	4,302.63	2.97	2.77	5.74
1,000	2,225.13	2,770.00	4,995.13	2.23	2.77	5.00

Loader Loose Hay Stacking System

The hay is cut with a mower and later raked into windrows. The hay is bucked into stacks in a stack frame by means of a loader with a push-off. The loose haystacks are moved later by a stack mover to the feeding area. One worker was required for this hay harvesting system.

The machinery required for this hay harvesting system is:

- Mower: 9' pull-type
- Rake: 9' side delivery
- Stack frame: medium size
- Tractor: 60-75 horsepower, used at 50 percent load
- Loader with push-off: medium size
- Tractor: 40-55 horsepower, used at 50 percent load

The total allocated investment for this hay harvesting system was \$4,889.00.

The costs for this system were:

Fixed Costs

Shelter and insurance	\$ 48.89
Depreciation	425.64
Interest	<u>215.12</u>
TOTAL FIXED COSTS	\$ 689.65

Variable Costs Per Ton

Mower:

Labor	\$.54	
Fuel	.22	
Lubrication	.03	
Repairs	.30	\$ 1.09

Rake:

Labor	.38	
Fuel	.15	
Lubrication	.02	
Repairs	.14	\$.69

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 \$ 4.23

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

TABLE 9. COSTS FOR LOADER LOOSE HAY STACKING SYSTEM, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$689.65	\$ 211.50	\$ 901.15	\$13.79	\$4.23	\$18.02
250	689.65	1,057.50	1,747.15	2.76	4.23	6.99
500	689.65	2,115.00	2,804.65	1.38	4.23	5.61
750	689.65	3,172.50	3,862.15	.92	4.23	5.15
1,000	689.65	4,230.00	4,919.65	.69	4.23	4.92

Hay Feeding Costs

Hay feeding costs are part of the costs of a total haying system. Three hay feeding systems were necessary to match the hay harvesting systems. The three systems for feeding hay are for baled hay, big bales, and loose hay.

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 are 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, 4-ton capacity

The total 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 cost 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

One big bale is fed at a time with this feeding system. The bale is carried by a loader mounted on a tractor from the place where it was stored to where it is 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 eat 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.

Loose Hay Feeding System

The hay is removed from the loose haystack with a grapple fork on a loader with this feeding system. 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, 4-ton capacity

The total allocated investment for this hay feeding system was \$2,735.40.

The total annual fixed cost for this hay feeding system was \$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 along with the amount of hay wasted by cattle after they have been fed is considered a part of the total haying costs. Storage losses are expressed as a percent of total hay stored and feeding losses are given as a percentage of total hay fed.

In order to consider hay losses, loss percentages must be converted to a dollar value. The dollar loss per ton is calculated by multiplying the percentage loss by the value of a ton of hay. For this study a value of \$20 per ton was used for tame hay. The dollar costs of hay losses are added to hay harvesting and feeding costs to obtain the total cost of haying. The percentage losses and dollar losses for different hay harvesting and feeding systems are given in Table 10.

TABLE 10. STORAGE AND FEEDING LOSSES BASED ON \$20 PER TON HAY FOR DIFFERENT HAY HARVESTING AND FEEDING SYSTEMS, 1973

Type of Hay	Storage Loss		Feeding Loss	
	percent ^a	dollar	percent ^b	dollar
Loose Hay (Loader Stacker)	3.5	.70	2.34	.46
Bales	4.5	.90	4.00	.80
Big Bales	3.5	.70	4.40	.88
Loose Hay (Stacking Wagon)	3.5	.70	2.34	.46

^aStevens, Delwin M., and Don R. Hamm, Hay Harvesting, Storing, and Feeding Methods in Wyoming--An Economic Analysis, Bulletin No. 590, Department of Agricultural Economics, Agricultural Experiment Station, University of Wyoming, Laramie, July, 1973.

^bSmith, Bill, et al., 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.

Total Haying Costs

To arrive at total haying costs, each harvesting system was matched with a complementary 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. Adding the variable cost per ton for hay harvesting and hay feeding and storage and feeding losses per ton, the total 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 can be calculated.

Baling and Manually Stacking Bales

The baling and manually stacking bales system was matched with a baled hay feeding system to make a complete haying system. Adding the fixed costs of \$837.57 for hay harvesting and \$403.47 for hay feeding gives a \$1,241.04 total fixed cost for the complete haying system. The variable cost per ton of \$13.15 is calculated by adding the \$9.84 variable cost per ton for hay harvesting, the \$1.61 per ton hay feeding variable cost, and the \$1.70 hay losses. The total annual costs and the costs per ton for this haying system are presented in Table 11. The costs for the other eight haying systems are calculated in the same way.

TABLE 11. COSTS FOR BALING AND MANUALLY STACKING BALES WITH BALE FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,241.04	\$ 657.50	\$ 1,898.54	\$24.82	\$13.15	\$37.97
250	1,241.04	3,287.50	4,528.54	4.96	13.15	18.11
500	1,241.04	6,575.00	7,816.04	2.48	13.15	15.63
750	1,241.04	9,862.50	11,103.54	1.65	13.15	14.81
1,000	1,241.04	13,150.00	14,391.04	1.24	13.15	14.39

Bale Accumulator System

The bale accumulator harvesting system is paired with a baled hay 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 12.

Small Automatic Bale Wagon System

The small automatic bale wagon harvesting 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 13.

TABLE 12. COSTS FOR BALE ACCUMULATOR HAY HARVESTING AND HAY FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,692.84	\$ 376.50	\$2,069.34	\$33.86	\$7.53	\$41.39
250	1,692.84	1,882.50	3,575.34	6.77	7.53	14.30
500	1,692.84	3,765.00	5,457.84	3.39	7.53	10.92
750	1,692.84	5,647.50	7,340.34	2.26	7.53	9.79
1,000	1,692.84	7,530.00	9,222.84	1.69	7.53	9.22

TABLE 13. COSTS FOR SMALL AUTOMATIC BALE WAGON SYSTEM FOR HAY HARVESTING WITH A BALED HAY FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,998.11	\$ 355.50	\$2,353.61	\$39.96	\$7.11	\$47.07
250	1,998.11	1,777.50	3,775.61	7.99	7.11	15.10
500	1,998.11	3,555.00	5,543.11	4.00	7.11	11.09
750	1,998.11	5,332.50	7,320.61	2.66	7.11	9.76
1,000	1,998.11	7,110.00	9,098.11	2.00	7.11	9.10

Large Automatic Bale Wagon System

The large automatic bale wagon harvesting 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 14.

TABLE 14. COSTS FOR LARGE AUTOMATIC BALE WAGON SYSTEM FOR HAY HARVESTING WITH A BALED HAY FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$2,367.97	\$ 355.50	\$2,722.97	\$47.36	\$7.10	\$54.46
250	2,367.97	1,775.00	4,142.97	9.47	7.10	16.57
500	2,367.97	3,550.00	5,917.97	4.74	7.10	11.84
750	2,367.97	5,325.00	7,692.97	3.16	7.10	10.26
1,000	2,367.97	7,100.00	9,467.97	2.37	7.10	9.47

Small Big Bale System

The small big bale harvesting 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 15.

TABLE 15. COSTS FOR SMALL BIG BALE SYSTEM FOR HAY HARVESTING WITH A BIG BALE FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,382.98	\$ 286.50	\$1,669.48	\$27.66	\$5.73	\$33.39
250	1,382.98	1,432.50	2,815.47	5.53	5.73	11.26
500	1,382.98	2,865.00	4,247.98	2.77	5.73	8.50
750	1,382.98	4,297.50	5,680.48	1.84	5.73	7.57
1,000	1,382.98	5,730.00	7,112.98	1.38	5.73	7.11

Large Big Bale System

The large big bale harvesting 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 16.

TABLE 16. COSTS FOR LARGE BIG BALE SYSTEM FOR HAY HARVESTING WITH A BIG BALE FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,619.06	\$ 273.00	\$1,892.06	\$32.38	\$5.46	\$37.84
250	1,619.06	1,365.00	2,984.06	6.48	5.46	11.94
500	1,619.06	2,730.00	4,349.06	3.24	5.46	8.70
750	1,619.06	4,095.00	5,714.06	2.16	5.46	7.62
1,000	1,619.06	5,460.00	7,079.06	1.62	5.46	7.08

Small Loose Hay Stacking Wagon System

The small loose hay stacking wagon harvesting system is paired with a loose hay feeding system to make a complete haying system. The total annual costs and the costs per ton for the complete haying system are presented in Table 17.

TABLE 17. COSTS FOR SMALL LOOSE HAY STACKING WAGON SYSTEM FOR HAY HARVESTING WITH A LOOSE HAY FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$2,011.72	\$ 235.00	\$2,246.72	\$40.23	\$4.70	\$44.93
250	2,011.72	1,175.00	3,186.72	8.05	4.70	12.75
500	2,011.72	2,350.00	4,361.72	4.02	4.70	8.72
750	2,011.72	3,525.00	5,536.72	2.68	4.70	7.38
1,000	2,011.72	4,700.00	6,711.72	2.01	4.70	6.71

Large Loose Hay Stacking Wagon System

The large loose hay stacking wagon harvesting system is matched 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 18.

TABLE 18. COSTS FOR LARGE LOOSE HAY STACKING WAGON SYSTEM FOR HAY HARVESTING WITH A LOOSE HAY FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$2,678.56	\$ 273.50	\$2,912.06	\$53.57	\$4.75	\$58.32
250	2,678.56	1,187.50	3,866.06	10.71	4.75	15.46
500	2,678.56	2,375.00	5,053.56	5.36	4.75	10.11
750	2,678.56	3,562.50	6,241.06	3.57	4.75	8.32
1,000	2,678.56	4,750.00	7,428.56	2.68	4.75	7.43

Loader Loose Hay Stacking System

The loader loose hay stacking harvesting 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 19.

TABLE 19. COSTS FOR LOOSE HAY STACKING SYSTEM FOR HAY HARVESTING WITH A LOOSE HAY FEEDING SYSTEM FOR NATIVE HAY, 1973

Tons	Total Annual Costs			Costs Per Ton		
	TFC	TVC	TC	AFC	AVC	ATC
50	\$1,143.08	\$ 310.50	\$1,453.58	\$22.86	\$6.21	\$29.07
250	1,143.08	1,552.50	2,695.58	4.57	6.21	10.78
500	1,143.08	3,105.00	4,248.08	2.29	6.21	8.50
750	1,143.08	4,657.50	5,800.58	1.52	6.21	7.73
1,000	1,143.08	6,210.00	7,353.08	1.14	6.21	7.35

The nine native haying systems considered in this study can be placed into three groups. Group I is for small tonnages (less than 200 tons) harvested annually. Group I contains the baling and manually stacking bales, bale accumulator, and loader loose hay stacking systems. Group II is for medium tonnages (200-600 tons) harvested annually. Group II contains the small automatic bale wagon, small big baler, and small loose hay stacking wagon systems. Group III is for large tonnages (greater than 600 tons) of hay harvested annually. Group III contains the large automatic bale wagon, large big baler, and large loose hay stacking wagon systems. The cost curves for Groups I, II, and III haying systems are shown in Figures 1, 2, and 3, respectively.

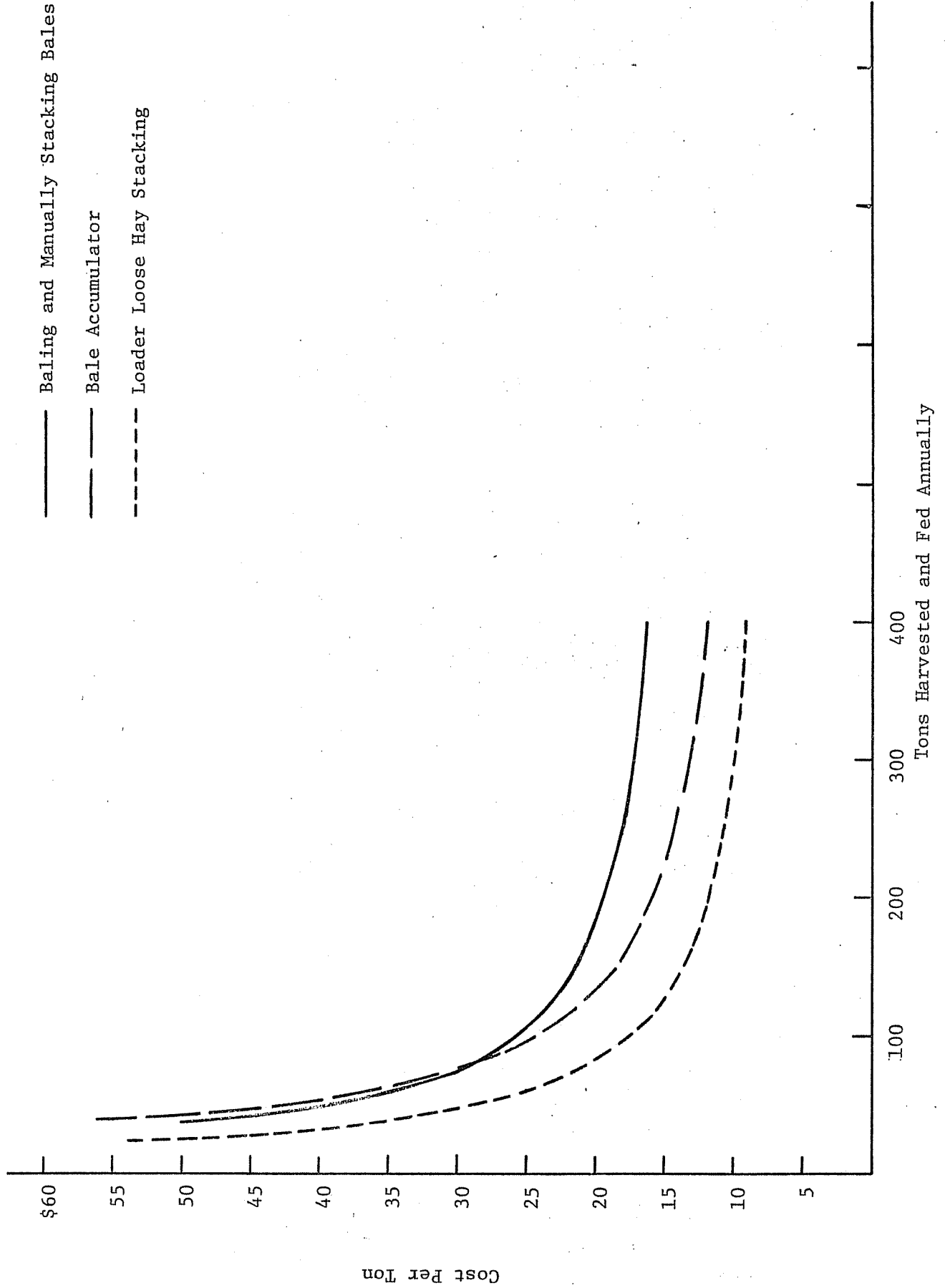


Figure 1. Cost Per Ton of Hay Harvested and Fed Annually for Group I Haying Systems

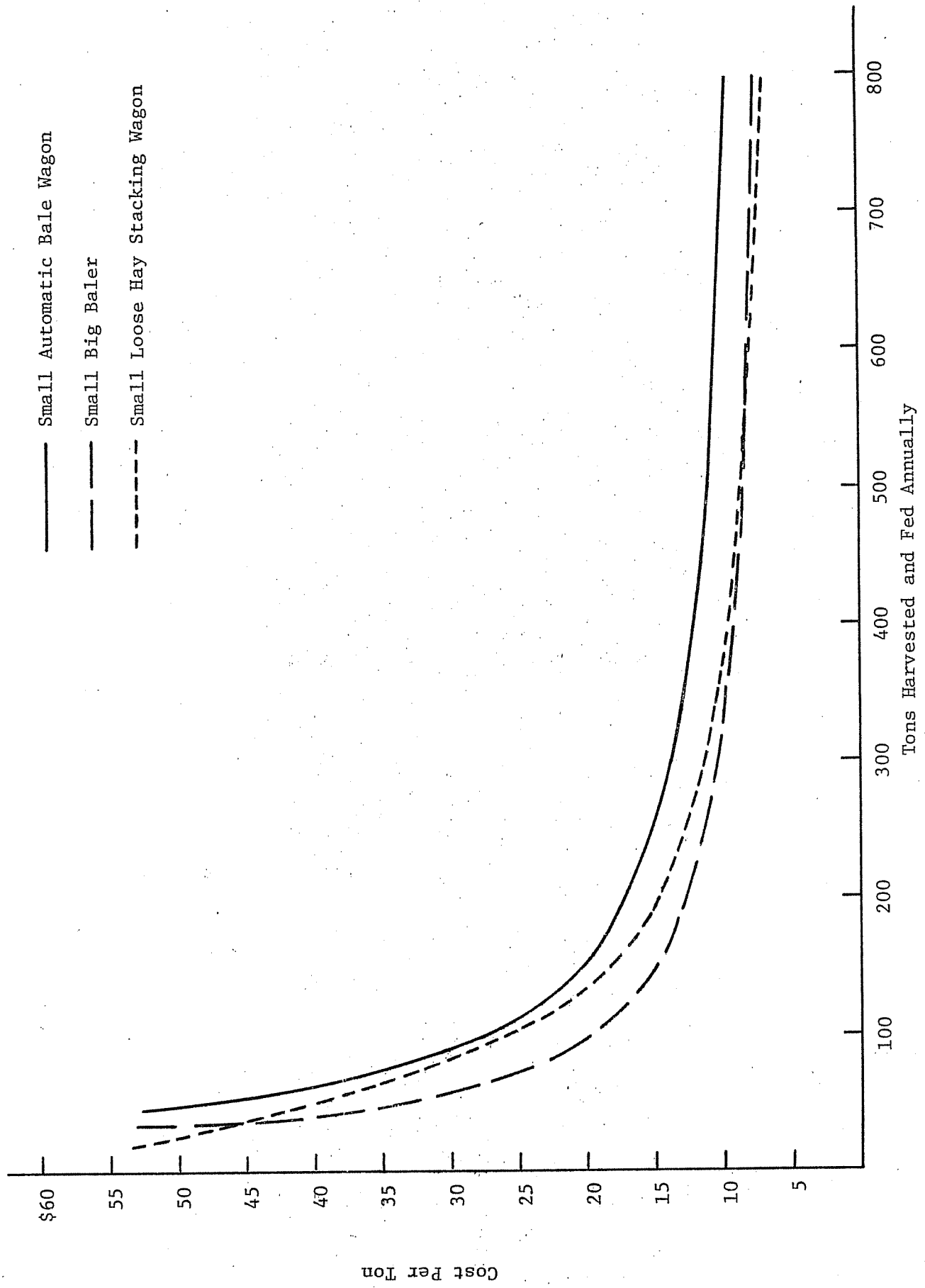


Figure 2. Costs Per Ton of Hay Harvested and Fed Annually for Group II Haying Systems

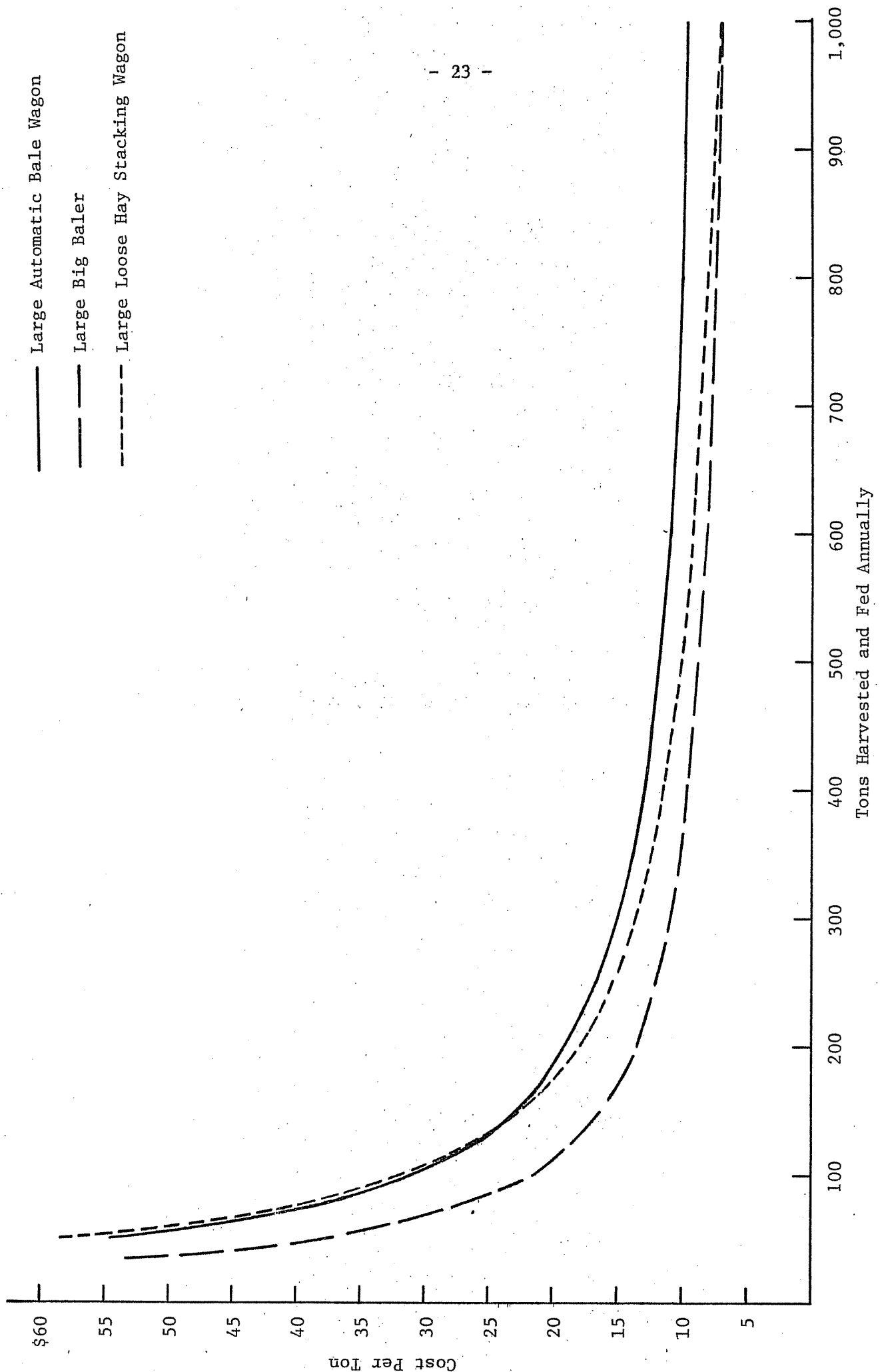


Figure 3. Cost Per Ton of Hay Harvested and Fed Annually for Group III Haying Systems

Conclusions

Substantial economies of size exist in native haying systems. Within each of the three groups of haying systems, considerable cost differences are found. Generally, lower costs per ton can be attained when larger amounts of hay are harvested. Highly mechanized harvesting systems have a significant cost advantage when large amounts of hay are harvested.

In Group I the loader loose hay stacking system has the lowest total haying costs for all tonnages harvested and fed annually. Group II has two systems which are least cost. The small big baler is the least cost haying system with up to 550 tons harvested and fed annually. Beyond 550 tons, the small loose hay stacking wagon becomes the least cost haying system. The practical upper limit for systems in Group II is 600 tons harvested and fed annually, so the small big baler system would be considered the least cost system for this group unless the system was to be used to harvest an exceptionally large number of tons annually. The large big bale system is the least cost system for Group III complete haying systems. This system has the lowest cost per ton of hay harvested and fed for very large tonnages annually.

LIST OF TABLES

<u>Table No.</u>		<u>Page</u>
1	COSTS FOR SYSTEM OF BALING AND MANUALLY STACKING BALES, 1973	3
2	COSTS FOR BALE ACCUMULATOR HAY HARVESTING SYSTEM, 1973	4
3	COSTS FOR SMALL AUTOMATIC BALE WAGON SYSTEM, 1973	6
4	COSTS FOR LARGE AUTOMATIC BALE WAGON SYSTEM, 1973	7
5	COSTS FOR SMALL BIG BALER SYSTEM, 1973	9
6	COSTS FOR LARGE BIG BALER SYSTEM, 1973	10
7	COSTS FOR SMALL LOOSE HAY STACKING WAGON SYSTEM, 1973	12
8	COSTS FOR LARGE LOOSE HAY STACKING WAGON SYSTEM, 1973	13
9	COSTS FOR LOADER LOOSE HAY STACKING SYSTEM, 1973	14
10	STORAGE AND FEEDING LOSSES BASED ON \$20 PER TON HAY FOR DIFFERENT HAY HARVESTING AND FEEDING SYSTEMS, 1973	16
11	COSTS FOR BALING AND MANUALLY STACKING BALES WITH BALE FEEDING SYSTEM FOR NATIVE HAY, 1973	17
12	COSTS FOR BALE ACCUMULATOR HAY HARVESTING AND HAY FEEDING SYSTEM FOR NATIVE HAY, 1973	18
13	COSTS FOR SMALL AUTOMATIC BALE WAGON SYSTEM FOR HAY HARVESTING WITH A BALED HAY FEEDING SYSTEM FOR NATIVE HAY, 1973	18
14	COSTS FOR LARGE AUTOMATIC BALE WAGON SYSTEM FOR HAY HARVESTING WITH A BALED HAY FEEDING SYSTEM FOR NATIVE HAY, 1973	18
15	COSTS FOR SMALL BIG BALE SYSTEM FOR HAY HARVESTING WITH A BIG BALE FEEDING SYSTEM FOR NATIVE HAY, 1973	19
16	COSTS FOR LARGE BIG BALE SYSTEM FOR HAY HARVESTING WITH A BIG BALE FEEDING SYSTEM FOR NATIVE HAY, 1973	19
17	COSTS FOR SMALL LOOSE HAY STACKING WAGON SYSTEM FOR HAY HARVESTING WITH A LOOSE HAY FEEDING SYSTEM FOR NATIVE HAY, 1973	19
18	COSTS FOR LARGE LOOSE HAY STACKING WAGON SYSTEM FOR HAY HARVESTING WITH A LOOSE HAY FEEDING SYSTEM FOR NATIVE HAY, 1973	20
19	COSTS FOR LOOSE HAY STACKING SYSTEM FOR HAY HARVESTING WITH A LOOSE HAY FEEDING SYSTEM FOR NATIVE HAY, 1973	20