An Economic Analysis of Tame Hay Harvesting Systems in North Dakota

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The number of cattle on North Dakota farms and ranches has increased from 2,088,000 head on January 1, 1963, to a January 1, 1973, total of 2,435,000 head (4). These increased cattle numbers mean more feed will have to be produced by North Dakota farmers and ranchers. The importance of hay as a source of cattle feed is reflected in North Dakota's ranking ninth in the United States in production of all hay in 1972 (3). Haying has always been one of the most labor intensive operations for farmers and ranchers. The stockman is faced with an increased need for hay but often no additional labor with which to harvest his hay. If the farmer is to continue a hay enterprise and if adequate labor is not available, he may be forced to switch to a modern capital intensive hay harvesting system.

Description of Harvesting Systems

Eleven tame hay harvesting systems were considered for this study, ranging from very labor-intensive systems to a one-man complete hay harvesting system. These systems fall into three groups, involving small, medium and large tonnages harvested annually. The purpose of the study was to determine the least-cost complete haying system for each of the three group sizes. Budgeting was used to arrive at the total annual cost of harvesting and feeding hay.

The group with small tonnages harvested annually contains three systems. System I is baling tame hay and manually stacking the bales. With this system the hay is cut with a self-propelled swather and harvested by pulling a wagon behind the baler, with two men on it to stack bales. The wagon must be pulled to the hay stack where the men unload and stack the bales for storage until they are fed. System II is the bale accumulator system. The hay is cut with a self-propelled swather and baled. Then the accumulator drops the bales in groups of eight, and the groups are picked up by a tractor and loader with a special fork and loaded on a wagon. The wagon is unloaded and the bales stacked with the loader and special bale fork. The loader-loose hay stacking system comprises System III. With this system the hay is cut with a self-propelled swather and bucked into stacks, using a stackframe with a loader and push-off. The stacks are moved later with a stackmover.

Four systems make up the group for medium tonnages of hay harvested annually. System IV is a small automatic bale wagon system. A self-propelled swather cuts the hay for this system. The hay is baled and the bales are dropped on the ground. The automatic bale wagon picks up the bales, stacks them on the wagon, and unloads and stacks the bales where they are to be stored until fed. A small-capacity big-bale system makes up System V. The hay is cut with a self-propelled swather, and a big baler which makes 1,500 pound round bales is used to harvest the hay. A special carrier is used to haul one bale at a time to a storage area. System VI is a small tame hay chopping system. The hay is cut with a self-propelled swather. A forage harvester chops the hay and blows it into forage wagons. The hay is hauled to a pile, where it is unloaded and packed for storage until fed. A small-capacity loose hay stacking wagon system for tame hay comprises System VII. With this system the hay is cut with a self-propelled swather. The hay is harvested with a loose hay stacking wagon which blows it into a wagon and compresses it into a compact haystack. The hay is hauled to the area where it is unloaded and stored until fed. The group of systems capable of harvesting the larger tonnages annually is composed of four systems. System VIII is a large automatic bale wagon system. This system operates the same as System IV but uses a larger automatic bale wagon. System IX is the large big-bale system. This system has a larger big baler than System V but operates the same. The large hay chopping system makes up System X. This system operates the same as System VI but uses a larger capacity forage harvester. The large loose hay stacking wagon comprises System XI. This system operates the same as System VII but uses a larger loose hay stacking wagon.

The labor required for each system, the investment, the fixed costs and the variable cost per ton for each of the 11 hay harvesting systems are presented in Table 1.

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Table 1. Labor Required, Investment*, and Costs for Tame Hay Harvesting System, 1973.

System	Labor Required	Investment	Annual Fixed Costs	Variable Costs Per Ton			
				Labor	Fuel and Lubrication	Repairs	Twine	Total
I	3 men	$ 5,710.15	$ 798.92	$7.34	$ .41	$ .32	$ .60	$8.67
II	2 men	9,561.95	1,396.45	1.30	.70	.44	.60	3.04
III	1 man	4,270.15	649.61	.86	.48	.21	—	1.55
IV	2 men	10,944.45	1,454.64	.98	.55	.49	.60	2.62
V	1 man	6,915.15	977.47	1.14	.71	.33	.15	2.33
VI	3 men	12,011.35	1,657.65	1.02	.64	.28	—	1.94
VII	1 man	10,590.15	1,519.46	.66	.40	.48	—	1.54
VIII	2 men	13,861.55	1,950.38	.78	.61	.50	.60	2.49
IX	1 man	8,848.90	1,245.51	.78	.68	.33	.15	1.94
X	3 men	14,749.80	2,052.57	.80	.60	.23	—	1.63
XI	1 man	15,493.90	2,215.36	.50	.42	.55	—	1.47

* *Investment includes a prorated share of tractors and swather.*

Hay Feeding Costs

Total costs of supplying hay to livestock include hay feeding costs, storage and feeding losses in addition to hay harvesting costs. To find the hay feeding costs, a hay feeding system was matched to each of the 11 hay harvesting systems. Investments in both the hay harvesting and hay feeding systems were allocated so no investments would overlap. Systems to feed regular square bales, loose hay, big bales and haylage were matched to the proper hay harvesting procedure to arrive at a complete haying system. Labor required, investment, fixed costs and variable costs per ton for a hay feeding system to match each hay harvesting system is given in Table 2.

Storage and feeding losses are an often overlooked part of haying costs. Losses during storage are calculated as a percentage of total hay stored, while feeding losses are given as a percentage of total hay fed. These percentage losses must be converted to a dollar value in order to be incorporated into haying costs. A value of $30 per ton was assigned to tame hay so the losses could be calculated in dollar form. The storage and feeding losses for each type of hay harvesting system are given in Table 3.

Total costs of haying for the 11 hay harvesting systems can be found by adding up the harvesting costs, feeding costs, and the costs for storage and feeding losses. Total investment for System I is found by adding the harvesting investment of $5,710.15 and the feeding investment of $2,453.40 to get $8,163.55. Total annual fixed costs of $1,202.39 are found by summing total annual fixed costs for hay harvesting and feeding. By adding the variable costs per ton for hay harvesting, feeding, and feeding and storage losses, the total variable cost per ton for System I is $12.83. Total costs per ton of hay harvested associated with System I are shown in Figure 1. Total annual costs and costs per ton for the other 10 systems are calculated in the same manner and are summarized in Figures 2 and 3. Total costs for the 11 haying systems are summarized in Table 4.

Table 2. Labor Required, Investment*, and Costs for Feeding System to Match Each Tame Hay Harvesting System, 1973.

System	Labor Required	Investment	Annual Fixed Costs	Variable Costs Per Ton			
				Labor	Fuel and Lubrication	Repairs	Total
I	1 man	$ 2,453.40	$ 403.47	$1.00	$ .44	$ .17	$1.61
II	1 man	1,515.90	247.38	1.00	.44	.17	1.61
III	1 man	2,753.40	453.43	.50	.22	.10	.82
IV	1 man	2,453.40	403.47	1.00	.44	.17	1.61
V	1 man	2,203.40	366.86	.40	.17	.07	.64
VI	1 man	2,413.40	426.12	.66	.29	.23	1.18
VII	1 man	2,753.40	453.43	.50	.22	.10	.82
VIII	1 man	2,453.40	403.47	1.00	.44	.17	1.61
IX	1 man	2,203.40	366.86	.40	.17	.07	.64
X	1 man	2,413.40	426.12	.66	.29	.23	1.18
XI	1 man	2,753.40	453.43	.50	.22	.10	.82

* *Investment includes a prorated share of tractor and loader.*

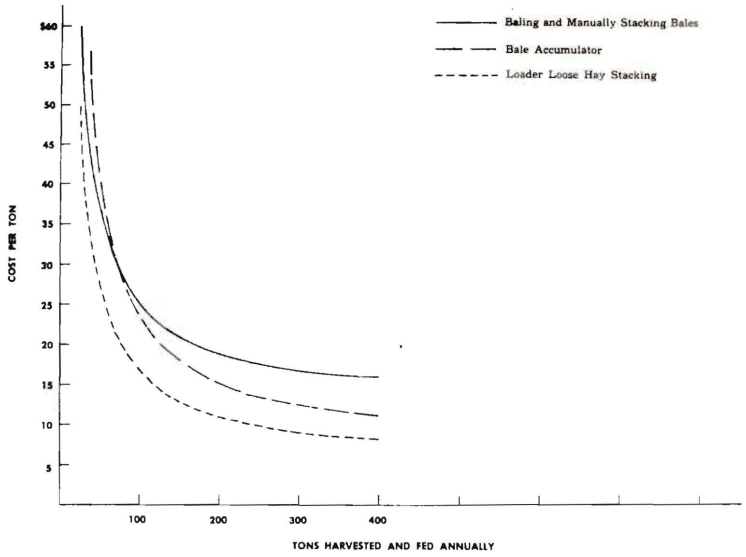

Figure 1. Cost Per Ton of Hay Harvested and Fed Annually for Group I Haying Systems.

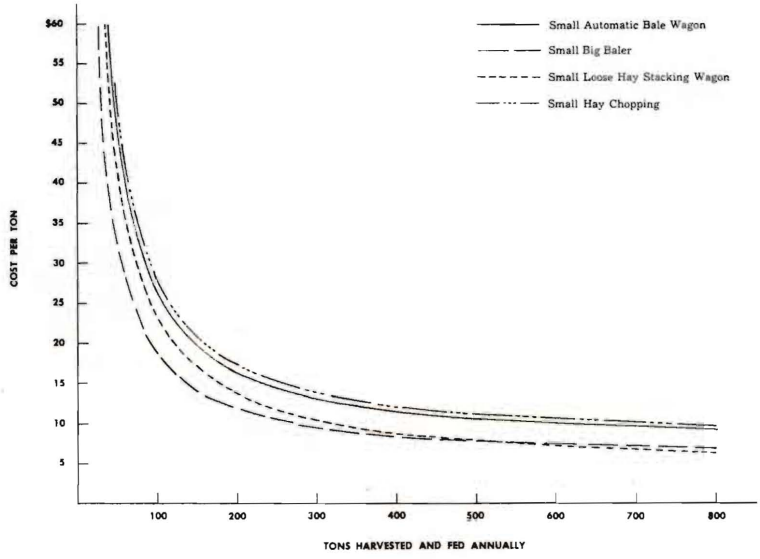

Figure 2. Cost Per Ton of Hay Harvested and Fed Annually for Group II Haying Systems.

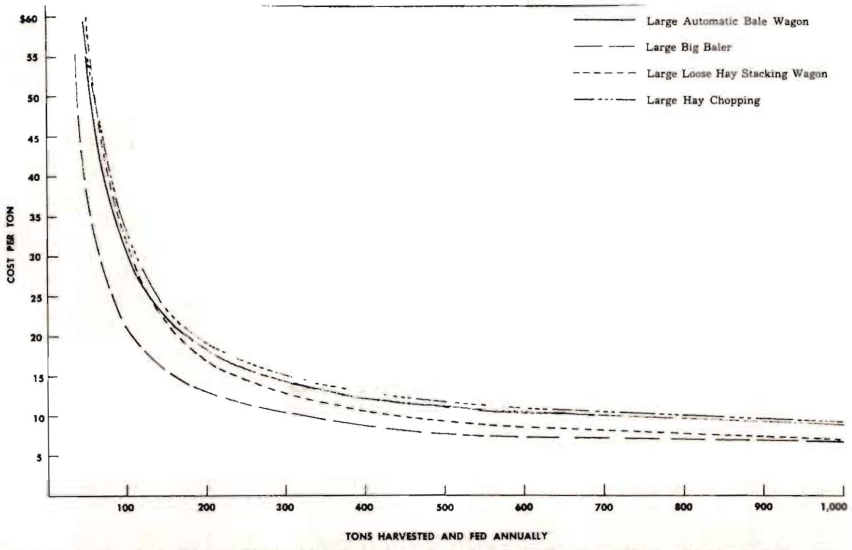

Figure 3. Cost Per Ton of Hay Harvested and Fed Annually for Group III Haying Systems.

Table 3. Storage and Feeding Losses Based on $30 Per Ton Hay for Different Hay Harvesting and Feeding Systems, 1973.

Type of Hay	Storage Loss		Feeding Loss	
	Per Cent[1]	Dollar	Per Cent[2]	Dollar
Loose Hay (loader-stacker)	3.5	$1.05	2.34	$ .70
Bales	4.5	1.35	4.00	1.20
Big Bales	3.5	1.05	4.40	1.32
Loose Hay (stacking wagon)	3.5	1.05	2.34	.70
Haylage	12.5	3.75		

[1] *Source: (2)*
[2] *Source: (1)*

Conclusions

Several conclusions can be drawn from this study. For farmers who harvest small tonnages of hay annually (less than 200 tons), System III, the loader loose hay stacking system, was the least-cost for all tonnages (Figure 1). Up to 75 tons harvested and fed annually, System I, baling and manually stacking bales, had the second lowest costs. But beyond 75 tons, System II, the bale accumulator, was the second lowest cost per ton.

Two systems were least-cost for the medium tonnages (200-600 tons) of hay harvested and fed annually. The smaller big baler system, System V, is least-cost for volumes up to 500 tons, but beyond that the small-capacity loose hay stacking wagon system, System VII, becomes least-cost (Figure 2). System IV, the small automatic bale wagon, has the third lowest cost per ton for this group, and System VI, the small capacity hay chopping system, had the highest cost per ton for this size group. The decision of which system is least-cost depends upon where within this range the farmer plans to produce.

The large-capacity big bale system, System IX, was the least-cost system for all tonnages harvested and fed annually for the large (more than 600 tons) volume group (Figure 3). System XI, the large loose hay stacking wagon, was the second least-cost; System VIII, the large automatic bale wagon, third least-cost; and System X, the large hay chopping system, was the most expensive of the systems in this group.

For a more complete analysis of these hay harvesting and hay feeding systems, consult Agricultural Economics Report Number 97.

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Table 4. Total Costs for Hay Harvesting Systems.

System	Investment			Annual Fixed Costs			Variable Costs Per Ton			
	Harvesting	Feeding	Total	Harvesting	Feeding	Total	Harvesting	Feeding	Losses	Total
I	$ 5,710.15	$2,453.40	$ 8,163.55	$ 798.92	$403.47	$1,202.39	$8.67	$1.61	$2.55	$12.83
II	9,561.95	1,515.90	11,077.85	1,396.45	247.38	1,643.83	3.04	1.61	2.55	7.20
III	4,270.15	2,743.40	7,013.55	649.61	453.43	1,103.04	1.55	.82	1.75	4.12
IV	10,944.45	2,453.40	13,397.85	1,454.64	403.47	1,858.11	2.62	1.61	2.55	6.78
V	6,915.15	2,203.40	9,188.55	975.47	366.86	1,342.33	2.33	.64	2.37	5.34
VI	12,011.35	2,413.40	14,424.75	1,657.65	426.12	2,083.77	1.94	1.18	3.75	6.87
VII	10,590.15	2,753.40	13,343.55	1,519.46	453.43	1,972.89	1.54	.82	1.75	4.11
VIII	13,861.55	2,453.40	16,314.95	1,950.38	403.47	2,353.85	2.49	1.61	2.55	6.65
IX	8,848.90	2,203.40	11,052.30	1,245.51	366.86	1,612.37	1.94	.64	2.37	4.95
X	14,749.80	2,413.40	17,163.20	2,052.57	426.12	2,478.69	1.63	1.18	3.75	4.20
XI	15,493.90	2,753.40	18,247.30	2,215.36	453.43	2,668.78	1.47	.82	1.75	4.04