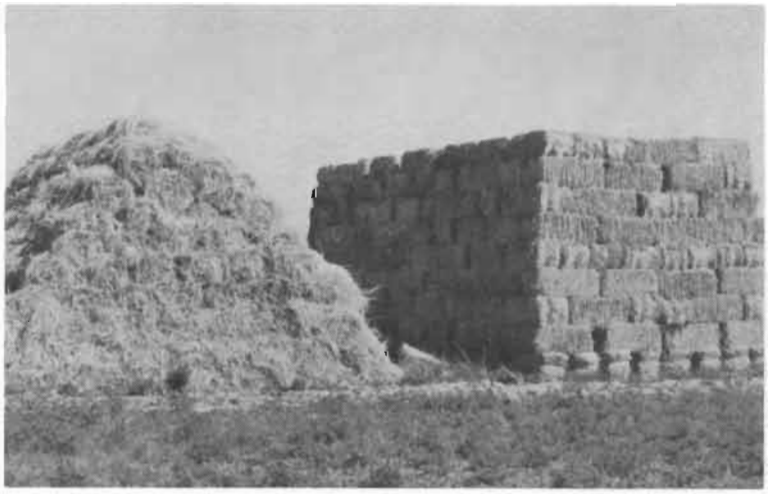
HAY HARVESTING, STORING AND FEEDING METHODS IN WYOMING

AN ECONOMIC ANALYSIS



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HAY HARVESTING, STORING AND FEEDING METHODS IN WYOMING --AN ECONOMIC ANALYSIS

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SUMMARY AND CONCLUSIONS

Harvesting is defined as getting the hay from a standing position into a stack or into a trench silo in the case of haylage. The major purpose of this economic analysis was to determine the costs associated with the various methods of harvesting, storing, and feeding hay in Wyoming.* The specific objectives were:

1) to determine the total and component costs to harvest, stack, and feed hay using various machine combinations;

2) to determine comparable efficiencies of different haying and feeding methods through the use of budgets; and

3) to provide farmers and ranchers with physical input-output data for use in budgeting and for use in decision making.

During the summer of 1971, harvesting-cost schedules were obtained by personal interviews from 196 farm and ranch operators scattered throughout the state. The most efficient harvesting method, costing $7.05 per ton, was to swathe and then loose stack hay with a Stakhand. This machine is described in the report. The most expensive method, costing $9.71 per ton, was to swathe alfalfa then cube with a mobile cuber. Intermediate in cost at $7.63 per ton was to harvest hay in the form of haylage using swathers and a pull-type forage harvester. The detailed results of the survey for eight different haying methods are shown in the Appendix.

Based mainly on performance rates, machines used, cost components, and other coefficients generated from the survey data and also using secondary data, budgets were prepared for the most common methods of harvesting hay. These budgets are useful in comparing cost components when harvesting hay by different methods and when harvesting different quantities by the same method. For example, one can compare costs when stacking baled hay with a front-end loader and when stacking baled hay with a bale wagon. Also one can compare costs when hay is stacked loose or baled, or when harvested as haylage or cubes.

The following table shows that for 1,200 tons the most efficient method, costing $9.02 per ton, is to swathe and then loose stack with a front-end loader. When hay is swathed and then loose stacked with a Stakhand, the cost is $11.39 per ton. When hay is swathed and baled, the cost is $11.50 per ton when stacked with a front-end loader and $12.07 per ton when stacked with a balewagon. The table also compares costs when larger or smaller quantities than 1,200 tons are harvested annually.

The cost of storing hay involves spoilage loss due to weather as well as a charge for the use of the storage facilities. Storage costs when 1,200 tons are stored range from $.80 per ton for cubes

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* **This is necessarily a long report since it investigates several important methods of harvesting and feeding hay in Wyoming. Casual readers might prefer to select from the table of contents only the sections which most interest them.**

to $1.53 per ton for haylage stored in a trench silo.

There are many different methods of feeding hay. Most of the methods budgeted involved a high degree of mechanization. When 1,200 tons are fed per year the feeding costs per ton range from $1.11 for cubed hay, to $3.76 when loose hay, stacked with a Stakhand, is fed with a stack-mover and a stack-feeder. While the latter method is rather expensive, it is used by some operators because it is a one-man operation. Also the cost per ton reduces somewhat when a larger tonnage is handled.

Cost per ton to harvest, store and feed various kinds and amounts of hay.

Kind of hay; Harvest method; Feeding method	Tons handled annually					
	400	800	1,200	1,600	2,000	2,400
Cubes (Fed with fel and truck)						
Total cost per ton	$25.52	$15.69	$12.53	$11.31	$11.06	$10.83
Haylage (Fed with fel and mixer box)						
Total cost per ton	$16.27	$12.10	$10.83	$10.31	$ 9.94	$ 9.70
Bales (Bale wagon and stack mover)						
Total cost per ton	$19.31	$13.75	$12.07	$11.45	$11.13	$10.89
Bales (Stacked and fed with flatbed truck)						
Total cost per ton	$16.31	$12.55	$11.50	$11.11	$10.82	$10.65
Loose (Stacked with fel and fed with gf)						
Total cost per ton	$12.91	$ 9.85	$ 9.02	$ 8.66	$ 8.46	$ 8.41
Loose (Stacked with Stakhand and fed with stack mover and stack feeder)						
Total cost per ton	$17.44	$12.72	$11.39	$10.94	$10.52	$10.18

Abbreviations: fel=front end loader; gf=grapple fork.

INTRODUCTION

Hay is Wyoming's most important cultivated crop, having an average value in recent years of over one-half of the total value of all crops produced. Of the 1.8 million acres used for crop production in Wyoming in 1970, 68%, or 1.2 million acres, were used to grow hay.[1]

Wyoming ranks 21st in the nation and 5th among the 11 western states in total number of acres of hay harvested. With an average yield of 1.55 tons per acre, Wyoming ranks 40th nationally and 11th in the western states.

Hay is raised in every county, with Fremont County ranking first in 1969, with 143,700 tons and Park County second, with 106,100 tons. Most of the hay raised is classified as either alfalfa or native wild hay. Wyoming's hay is produced on both irrigated and dryland meadows, with irrigated being the predominant type of production.

Need for the Study

Winter feed represents a large part of the cost of producing range beef cattle in Wyoming. From 1.5-2 tons of hay in the mountain valleys and .50-.75 tons in the plains are required to winter a beef cow at recommended levels of nutrition. Large cattle ranches require substantial volumes of forage for winter use. The production, harvesting, and storing of winter feed during a relatively short summer period is one of the greatest obstacles facing the typical cattle rancher.

Rising production costs, fluctuating farm prices, the competitive nature of agriculture, and the rising cost of living have all exerted economic pressures on Wyoming's farmers and ranchers. In order to survive, it has become increasingly necessary to rely on technological change and innovations to improve efficiency and overall profitability of farming operations. To reduce production costs and to improve profitability, farmers and ranchers are attempting to increase the efficientcy of farm labor, power, and machinery. Choosing the proper size and type of farm machinery for a particular operation and for greater efficiency can be a difficult process. Farmers and ranchers who produce hay are confronted with such important economic decisions as: Shall I bale, cut, or chop my hay or shall I stack it loose? What is the optimum combination of machines for my specific farm? Would it be cheaper to hire a custom operator? Shall I graze the poorer hay meadows and buy needed hay?

To answer these and other questions, farmers and ranchers need to know the costs of owning and operating specific hay machines. Also, they need information on performance rates and field capacities of the various machines and the cost of feeding hay, once it is in the stack. With this information, they can investigate means to reduce costs and increase efficiency.

Purpose and Objectives

The purpose of this economic analysis is to determine costs associated with the different hay harvesting machines, and with the different hay harvesting methods used in Wyoming. Specific objectives are:

1. to describe methods currently used to harvest and stack hay in Wyoming;
2. to determine total and component costs to harvest and stack hay using various machine combinations;
3. to determine and compare efficiencies of different haying methods through the use of budgets; and
4. to provide farmers and ranchers with physical input-output data for use in budgeting and management decisions.

Methodology

In the summers of 1970 and 1971, 196 survey questionnaires were collected by personal interviews with farmers and ranchers in 19 of the 23 counties in Wyoming. Respondents were questioned primarily on their haying operations. Questions concerning types of crops grown, and the

[1] **Wyoming Cooperative Crop and Livestock Reporting Service; USDA and Wyo. Dept. of Agriculture 8/17/72.**

number and kind of livestock kept, was also included in the questionnaire.

Basic methods of haying include baling, loose stacking, haylage, and cubing. The information collected was placed on data cards with one haying operation per card, and then sorted into groups for eight different methods. A computer program was used to array each of the various methods for several factors, including total harvesting costs per ton, and the machinery investment cost per ton harvested. Simple averages were made for each array, and the most efficient operators were compared with the least efficient.

COST THEORY AND PROCEDURES

For a farm or ranch to survive in the long run, all costs must be covered; that is, the income must be larger than or equal to the costs of production.

Fixed or ownership costs of owning haying machinery include depreciation, interest on investment, taxes, insurance, and housing. These costs are incurred whether the machine is used or not. As annual use increases, fixed costs are spread over more units (hours, tons, acres), and the fixed costs per unit becomes smaller. Variable costs of machine operation include fuel, repairs, lubrication, materials, and labor for service. These costs are a function of, and vary directly with annual use. It is assumed that variable costs are constant per unit of output.

Ownership or Fixed Costs

Depreciation is the loss in value and service capacity due to normal wear, rust, obsolescence, and weather. It is an annual allowance which may be set aside to replace the machine when it wears out. The three most common methods of calculating depreciation are straight line, declining balance, and sum-of-the-years digits. All these methods charge off the depreciable balance over the life of the machine, but differ in amount charged off in the various years. In this study the straight line method was used. The formula:

$$\text{Annual depreciation} = \frac{\text{New cost - Salvage value}}{\text{Expected years of use}}$$

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 its use. A rate of 7.5% was used on the average value of the machine. Average value is the new cost plus salvage value, divided by two.

Taxes are based on the average value of the machine. Actual levies vary considerably among school districts and communities; hence, the local rates should be used if available. For machines other than automobiles and trucks, 1% of the average value can be used to estimate annual taxes.

Housing is not as important in Wyoming as in areas of high humidity where machines depreciate faster, and usually need more repair, if not housed. Use of the farm shop is also included in the charge for housing. About 1% of the machine's average value can be used in Wyoming as an annual expense for housing. If a charge for housing is not included, higher depreciation rates should be used.

Insurance is a charge for the risk of loss due to fire, windstorms, and other hazards. Insurance is a real ownership cost of machinery and must be borne by the farmer. Actual insurance rates can be used for the average value of the machine. A rule of thumb for computing insurance is 0.6% of the average value.

A short-cut method which shows the approximate ownership costs is as follows: interest (7.5%); insurance (0.6%); taxes (1%); and housing (1%) — all these against the average value of the machine. These total to 10.1% of the average value or about 5% of the new value. To this must be added the annual depreciation to

get the total ownership cost. For example, if the machine is believed to last 10 years, then 10% depreciation plus 5% other fixed costs equals a total annual ownership cost of about 15% of the new value or 30% of the average value of the machine.

Operating or Variable Costs

Repair costs depend on annual use, the nature of the work done, how well the machine has been maintained, and how carefully it is handled. Repairs usually include the cost of parts and the labor required to fix the machine. Repair costs should be actual costs incurred for the specific machine. Actual repair costs were not available. An estimation was obtained by use of the following formula:

$$\text{Repair cost per hour} = \frac{\text{60 to 120\% of new cost}}{\text{hours of total life}}$$

For example, assume a tractor has a new cost of $10,000, and the repair cost during its life will be 120% of this figure, or $12,000. If the useful life of the tractor is 12,000 hours, then the repair cost is $1.00 per hour ($12,000/12,000 hours = $1). Certain other machines may have an estimated lifetime repair cost of 60 or 80% of the new value. For example, assume a cuber with a new cost of $38,000 has a wear-out life of 4,000 hours and the total life repair cost is 60% of the new cost, or $22,800. The repair cost per hour of use is $5.70 ($22,800/4,000 = $5.70). Repair cost in per cent of new cost for the machines used in this study is shown in Table 1.

Fuel is a major cost for operating machines and equipment with motors. Estimates of fuel consumption can be made for each machine, based on past records, information from manufacturers or from the Nebraska Tractor Tests.

Average gasoline consumption per hour for tractors is as follows: gallons per hour = (.1075) (pto hp. max.). For example, a tractor with a maximum rated pto horsepower of 50 would consume 5.4 gallons of gasoline per hour [(.1075) (50) = 5.4]. For diesel tractors, use .0765 times the maximum drawbar horsepower to estimate the gallons of fuel required per hour. Fuel prices were computed using 25 cents per gallon for gasoline and 20 cents per gallon for diesel fuel.

Lubrication costs include several items such as grease, hydraulic oil, crank case oil, and filters. Research concerning engine oil use for farm machines indicates that for most machines, engine oil consumption, including changes, ranges between .0250 - .0625 gallons per hour. Engine oil prices were $1.20 per gallon. An annual charge for other lubricants is 0.2% of the original cost of the machine.

Labor required to lubricate and maintain the machine is called service labor and was computed at the rate of $2 per hour. This normally amounts to 2-4% of the annual use of the machine. For example, if a machine is used 800 hours per year, an additional 24 hours should be charged for servicing the machine.

Three factors, other than the use of the machine, need to be considered when estimating the total cost of performing any given farm job. These include: 1) the cost of the labor of the machine operator, 2) the cost of the tractor to furnish the power, and 3) the cost of the materials, such as twine, baling wire, and preservatives when used with haylage.

Per Ton Costs

For cost analysis "per ton" costs are used more commonly than "total costs". Average fixed costs, average variable costs, and average total costs per ton are used in this study.

The total cost of the haying operation includes three components: 1) the fixed and variable costs for the machine and for the tractor when the machine is not self-propelled, 2) the expenses for materials such as baling wire and preservatives, and 3) a charge for the labor of the machine operator. Total haying machinery costs per farm were divided by the tons harvested to place the cost data on a "per ton" basis. Haylage was harvested with about 50% dry matter and other hay was harvested with about 90% dry matter. Then 1.8 (90/50 = 1.8) tons of haylage equals 1 ton of "other hay". Converting haylage to "other hay" in this manner makes it possible to compare all haying methods on the same dry matter basis.

The machinery investment per ton was computed by dividing the average machinery investment by the number of tons harvested.

Table 1. Cost information and performance rates for hay harvesting machines. (Basic data for synthesized hay harvesting budgets)

Machine (size-power source)	Estimated cost 1972	Cost per hour		Tons per hour		Wear-out hours*	Repair in percent of list price*
		Repair	Fuel	Range	Average		
Mower, 7 ft, 30 hp	$ 670	$ .40	$ ---	1.5-2.9	2.2	2,000	120
Rake, 8 ft, 30 hp	820	.33	---	1.8-3.5	2.6	2,500	100
Swather, 12 ft. sp	8,000	3.20	$1.25	4.0-6.0	5.0	2,500	100
Baler							
pto, 40 hp	3,800	1.22	---	3.0-5.0	4.0	2,500	60
sp	9,500	2.28	1.25	5.6-8.4	7.0	2,500	60
Forage harvester							
pto, 80 hp	4,000	1.60	---	3.2-5.4	4.3	2,000	80
sp	12,800	3.84	1.25	5.6-8.4	7.0	2,000	60
Sweep rake, 10 ft, sp	3,100	.74	1.50	2.1-4.3	3.2	2,500	60
Front-end loader							
Loose hay, 50 hp	2,150	.52	---	3.0-5.0	4.0	2,500	60
Baled hay, 50 hp	2,150	.52	---	4.0-6.0	5.0	2,500	60
Balewagons							
Small, 50 hp	4,500	1.35	---	2.4-4.8	3.6	2,000	60
Medium, 50 hp	7,500	2.25	---	3.5-5.5	4.6	2,000	60
Large, sp	15,050	4.52	1.50	6.0-9.0	7.5	2,000	60
Stakhand							
Small, 80 hp	8,450	2.03	---	2.4-3.6	3.0	2,500	60
Large, 100 hp	14,766	3.54	---	4.9-7.5	6.0	2,500	60
Retriever & feeder	8,600	2.06	---	2.0-4.0	3.0	2,500	60
Cuber, sp	38,000	5.70	1.20	3.5-5.5	4.5	4,000	80
Tractors, diesel							
100 hp	14,400	1.44	1.53			12,000	120
80 hp	12,800	1.28	1.22			12,000	120
50 hp	8,080	.81	.76			12,000	120
40 hp	6,050	.61	.61			12,000	120
30 hp	5,100	.51	.46			12,000	120
Tractors, gasoline							
50 hp	7,040	.70	1.35			12,000	120
40 hp	5,400	.54	1.08			12,000	120
30 hp	4,500	.45	.81			12,000	120

*Source: **Agricultural Engineers Yearbook,** published by American Society of Agricultural Engineers.

Abbreviations: hp=horsepower; sp=self-propelled.

HAYING COSTS IN WYOMING WHEN USING DIFFERENT HARVESTING METHODS

Methods of Harvesting

In this section a summary and comparison of costs of harvesting hay on 196 farms and ranches by different methods is presented. The details of cost components and a brief discussion of each method is given in the appendix. Costs are those incurred in getting hay from a standing position into a windrow as well as costs involved from the windrow into a stack, pile, or trench silo. In most cases hay is cut with a self-propelled swather, with or without a conditioner. A small percentage of Wyoming hay is harvested with mowers and side rakes. From the windrow, hay may be handled by any of the methods described below.

1. Baled and then stacked with: a) front-end loaders, b) pull-type balewagons, and c) self-propelled balewagons.
2. Loose stacked with: a) front-end loaders and b) Stakhands.
3. Harvested as haylage with: a) pull-type forage harvesters, and b) self-propelled forage harvesters.
4. Cubed with a mobile cubing unit.

Comparison of Hay Harvesting Methods

Eight methods of harvesting and stacking hay were analyzed and the results summarized (Table 2). This section briefly discusses organizational factors which influence cost of harvesting hay.

The eight methods are not readily comparable. Furthermore, they cannot be subjected to rigorous economic analysis due to differences in the total tons harvested by each method and other reasons. However, a few generalized statements can be made.

Method 1, cutting and raking with a swather and stacking loose hay with a Stakhand, resulted in a cost of $7.05 per ton, the lowest of the eight methods (Table 2).

Method 2, using swathers to cut and rake and front-end loaders to stack loose hay, had the second lowest cost of $7.19 per ton.

Method 3, using a self-propelled balewagon to stack baled hay, resulted in the third lowest cost of $7.23 per ton. The large tonnage harvested helped lower fixed costs and helped keep total costs down.

Method 4, harvesting haylage with a tractor-drawn forage harvester, was the fourth cheapest method with a cost of $7.63 per ton. A large tonnage of haylage again helped lower the cost.

Cubed hay, Method 8, is the most expensive method with a total cost of $9.71 per ton. A high machinery investment of $28.48 per ton resulting in high fixed costs was the main reason that cubing hay has the highest cost per ton. The high tonnage harvested, making for good labor efficiency in cubing, helped keep costs down but was more than offset by the high fixed machinery costs.

Harvesting legume hay in the form of cubes costs more per ton than most other methods. Part of this cost is offset, however, because there is little loss in storage, there is practically no risidual left in the manger and feeding cubes requires less labor than feeding other forms of hay.

The second highest cost, $9.03 per ton, was with Method 7, harvesting baled hay with a front-end loader. A high machinery investment and high labor costs were the big factors influencing this cost.

Harvesting loose hay with mowers and rakes and stacking with a front-end loader, method 6, had a cost of $8.06 per ton, the third highest. A very high labor cost of $3.58 per ton, was the main cause of this high cost.

Methods 1, 3, 5, and 8, which have the highest degree of mechanization and which have the most sophisticated types of machinery, also have the lowest labor costs and have the highest labor efficiency. Hay harvested by these four methods is never touched by man until after it is stacked. All physical labor is done by machine. The other four methods are spending more man hours harvesting and stacking hay. In general they have lower machinery investment and lower fixed costs, because of less mechanization.

Table 2. Comparison of eight methods of harvesting and stacking hay. (196 Farms and ranches in Wyoming, 1971)

	Method							
	1	2	3	4	5	6	7	8
Average harvesting cost per ton								
Fixed	$ 4.52	$ 3.56	$ 3.51	$ 3.61	$ 3.97	$ 2.76	$ 4.11	$ 5.53
Variable								
Labor	.86	1.87	1.32	2.11	1.38	3.58	2.33	1.55
All other	1.67	1.76	2.40	1.91	2.52	1.92	2.59	2.63
Total cost	$ 7.05	$ 7.19	$ 7.23	$ 7.63	$ 7.87	$ 8.06	$ 9.03	$ 9.71
Organizational factors								
Machinery investment per ton	$28.24	$23.86	$20.40	$22.19	$27.20	$19.25	$28.97	$28.48
Tons harvested per man hour	2.50	1.12	1.60	.98	1.72	.59	.95	1.52
Average yield per acre (tons)	3.02	1.50	2.75	4.76	2.86	1.41	2.77	4.89
Tons harvested per farm	1,321	893	1,732	1,510	934	1,163	1,430	1,760

Method:

1 Loose hay using swathers and Stakhand
2 Loose hay using swathers and front-end loader
3 Baled hay using swathers and self-propelled balewagon
4 Haylage using swathers and pull-type forage harvester
5 Baled hay using swathers and pull-type balewagons
6 Loose hay using mowers, rakes and front-end loaders
7 Baled hay using swathers and front-end loaders
8 Cubed hay using swathers and cubers

BUDGETS FOR VARIOUS METHODS OF HARVESTING HAY

Basic Data

Based largely on performance rates, machines used, cost components, and other coefficients generated from the survey analysis, but also using some secondary information sources, synthetic budgets have been prepared for different methods of harvesting hay. These budgets are useful in comparing cost components when harvesting hay by different methods, and when harvesting different quantities of hay by any one method. For example, one can compare costs when stacking baled hay with a front-end loader and when stacking baled hay with a balewagon. One can compare costs when hay is stacked loose or baled or when harvested as haylage or as cubes. Also, one can compare the cost per ton of harvesting and stacking from 200 to 2,000 tons of hay when using any of the various methods. For these reasons tables have been prepared showing the cost of harvesting and stacking various quantities of hay by several different methods.

The reader should recognize that this economic study is not a complete cost analysis. For example, if hay is harvested with a cuber it must lay in the field for a longer period than when baled or stacked loose. This practice tends to reduce yields of cubed hay as several days must elapse before the next irrigation can be applied. When hay is harvested as haylage there is a smaller loss of leaves than when other methods are used. There is less waste due to non-consumption of stems when feeding cubes or haylage as compared to feeding bales or loose hay. Since these differences are difficult to quantify they were ignored in this study.

Machinery investment costs for 1972, cost per hour for repair and fuel, machine wearout hours, and performance rates measured by tons harvested per hour are presented for several different haying machines and tractors (Table 1). This information constitutes much of the basic data used in preparing the synthetic budgets. For example, Table 1 indicates that a mower with a 7-foot cutter bar which can be mounted on a 30 hp tractor has an estimated investment cost in 1972 of $670. The performance rate based on information generated from the survey, ranges from 1.5 to 2.9 tons per hour, and averages 2.2 tons. The wearout life of the mower is 2,000 hours, and the repair cost for the life of the machine is 120% of list price or $804 ($670 x 1.20 = $804). This is 40 cents per hour ($804/2,000 = $.40).

Similar information is presented in this table for other machines, including swathers, balers, forage harvesters, sweep rakes, front-end loaders, balewagons, Stakhands, cubers, and different sizes of diesel-burning and gasoline-burning tractors.

The methodology used in computing the cost per ton to own and operate a mowing machine, when different amounts of annual use are assumed, is demonstrated in Table 3. For example, the 7-foot tractor-mounted mower, when used for 200 tons per year, has a total cost of $2.84 per ton. This reduces to $2.63 when 400 tons are put up, and to $2.58 per ton when 800 tons are harvested. The costs in Table 3 include the fixed and variable costs of the mower, and tractor, and also include the cost of man labor to operate the tractor. Similar information is given for siderakes, balers, swathers, balewagons, Stakhands, cubers, forage harvesters, sweeprakes, and front-end loaders (Table 4).

Calculating Specific Haying Machinery Costs

Before computing the cost of the various machines, certain assumptions were necessary:

1) Annual depreciation of tractors and other machines was based on years of life as shown in the 1970 Agricultural Engineers Yearbook.

2) Salvage values for these machines were computed as follows:

Years of life	12	11	10	9	8	7	6	5	4	3
% of new cost for sal. val.	10	12	14	16	18	20	22	24	26	28

Table 3. Fixed and variable costs for a mowing machine with different amounts of annual use. (Size: 7 foot; New value: $670; Tons per hour: 2.2; Wear-out hours: 2,000).

	Total costs with varying amounts of annual tonnage			
Tons per year:	200	400	600	800
Hours use per year:	91	182	273	364
Years of life:	12	9	7	5
Fixed costs of machine				
Depreciation	$50	$54	$ 76	$102
Interest	28	28	30	31
Taxes	4	4	4	4
Insurance	2	2	2	2
Housing	4	4	4	4
Total fixed costs	$88	$92	$116	$143
Variable costs of machine				
Lubrication	$ 3	$ 3	$ 3	$ 3
Service labor	7	14	22	29
Repair cost	36	73	109	146
Total variable costs	$46	$90	$134	$178
Annual cost of man labor	$182	$ 364	$ 546	$ 728
Annual cost of tractor	253	506	759	1,012
Total cost (machine, man, tractor)	$569	$1,052	$1,555	$2,061
Total cost per ton	$2.84	$2.63	$2.59	$2.58

3) The maximum annual use for any machine was between 400 and 500 hours. This represents 40 to 50 10-hour days, or occasionally, 12-hour days for certain machines.

4) Hay yields were assumed to be 1.25 tons per acre per cutting.

5) Tractors, used between 400 and 1,000 hours per year, were assumed to be used 80% of these hours for haying and 20% for other farm or ranch work. Tractors used in harvesting haylage were assumed to be used 50% of their time doing other farm work.

6) Only tractors burning diesel fuel were budgeted. If gasoline is used in the smaller size tractors the cost is slightly higher (Table 5).

Harvesting Baled Hay with Front-end Loaders

The most common method of haying in Wyoming is to swath and bale the hay, then pick up the bales and stack them with a front-end loader. A man is on the stack to arrange bales. Method 1 describes this system and shows the budgeted costs for different amounts of hay (Table 6). Machines used include a self-propelled swather, a self-propelled baler, and a front-end loader mounted on a 50 drawbar hp tractor. Kind of machines used is also given at the bottom of the table. This method of haying requires a machine investment of about $28,000. A four-man crew working a total of 113 10-hour days is required to harvest 1,800 tons. This is 28.25 days for each of four men (113/4 = 28.25). The cost per ton to swath, bale, and stack varying tonnages is as follows: $17.40 for 200 tons; $6.91 for 1,200 tons; and $6.50 for 1,800 tons (Figure 1).

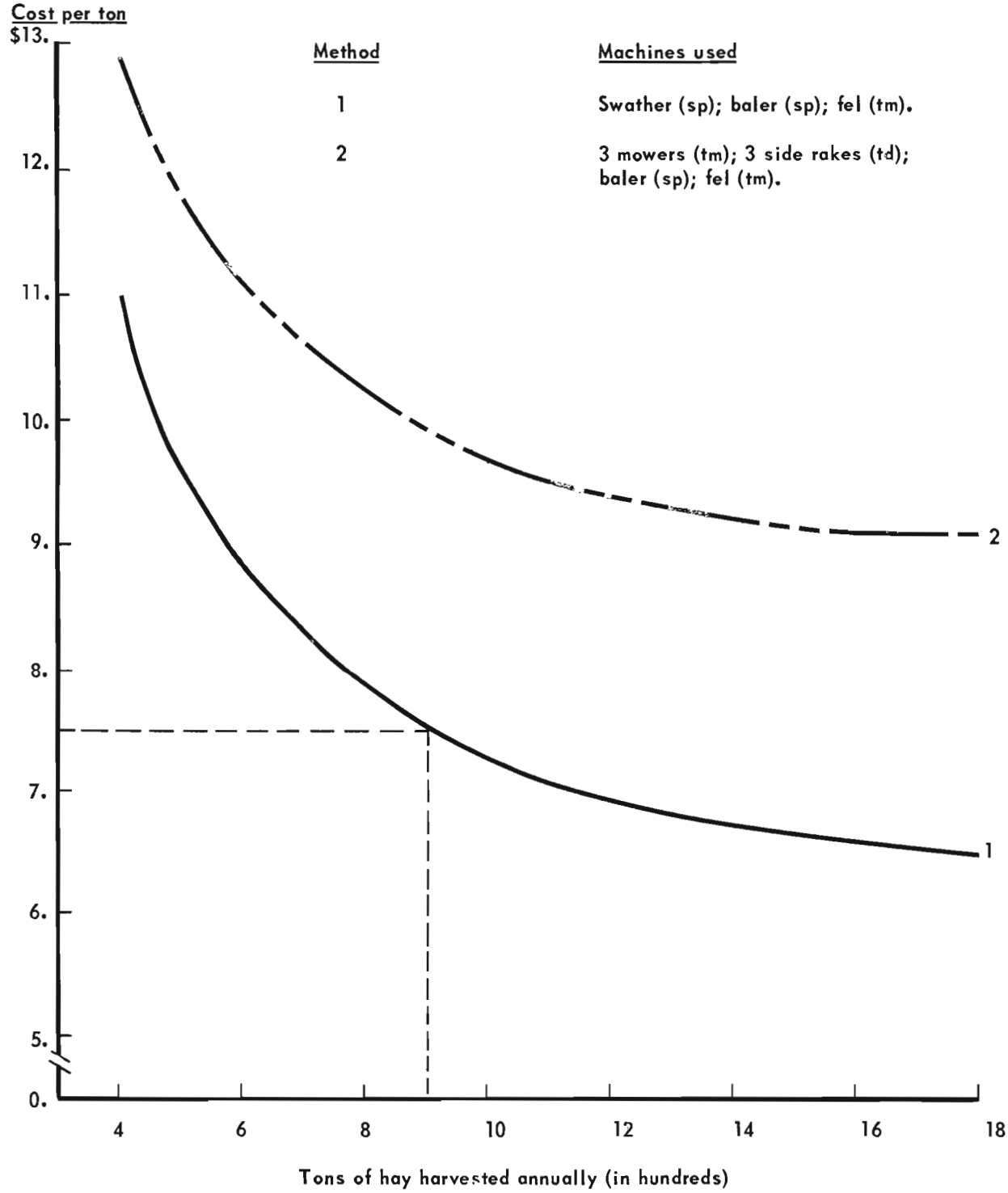


Figure 1. Cost per ton to harvest and stack baled hay – two methods

Table 4. Cost per ton to own and operate machines with different amounts of annual use. (Basic data used in synthetic budgets)

Machine: Kind and size	Cost per ton for different annual tonnages								
	200	400	600	800	1,000	1,200	1,400	1,600	1,800
Mower (tm) 7′	$ 2.84	$ 2.63	$ 2.59	$2.58	$ ---	$ ---	$ ---	$ ---	$ ---
Side rake (td) 8′	2.54	2.27	2.19	2.16	2.16	---	---	---	---
Balers									
(td)	4.28	3.01	2.44	2.44	2.36	2.30	2.27	2.16	---
(sp)	7.01	3.91	2.88	2.37	2.06	1.85	1.79	1.72	1.67
Swather (sp) 12′	6.56	3.95	3.08	2.71	2.49	2.42	2.34	2.30	2.24
Balewagons									
Small (td)	5.02	3.48	3.08	2.97	2.85	2.78	2.78	---	---
Medium (td)	6.76	4.26	3.41	3.20	3.07	2.97	2.90	2.83	2.70
Large (sp)	10.96	6.02	4.39	3.57	3.08	2.91	2.75	2.64	2.58
Stakhand									
Medium (td)	10.00	7.15	6.29	6.07	5.82	---	---	---	---
Large (td)	12.16	7.41	5.80	5.00	4.54	4.21	4.10	4.06	3.98
Cuber (sp)	32.82	17.44	12.30	9.74	8.19	7.17	6.43	6.19	6.08
Forage harvester									
(td)	5.74	4.42	3.98	3.30	3.01	2.83	2.79	2.68	---
(sp)	9.46	5.26	3.38	3.18	2.76	2.48	2.41	2.31	2.25
Sweep rake (sp)	3.43	2.43	2.10	1.98	1.92	1.87	---	---	---
Front-end loader									
Baled hay (tm)*	3.98	3.25	3.01	2.91	2.87	2.86	2.72	2.69	2.60
Loose hay (tm)	3.54	2.80	2.57	2.50	2.44	2.31	2.29	---	---

Abbreviations: tm=tractor-mounted; td=tractor-drawn; sp=self-propelled.

*Costs include also a man to arrange bales on the stack.

The curves in Figure 1 were derived by plotting the costs per ton as presented in Table 6 and then connecting these points with the use of a French curve. The curves show the estimated cost per ton at any given tonnage. For example, if 900 tons were to be harvested by method 1, the estimated cost per ton would be $7.50.

In a few areas of Wyoming, farmers have not yet adopted the use of a swather. Rather, they prefer to use mowers and rakes. To harvest 1,800 tons in about 25 days, a typical nine-man haying outfit would consist of three tractor-mounted mowers, three tractor-drawn siderakes, a self-propelled baler, and a front-end loader mounted on a 50 drawbar hp tractor and a man on the stack. If only 200 tons are harvested annually, the cost per ton would be $18.24; at 1,200 tons $9.39, and at 1,800 tons, $9.04 per ton. (Table 6, Method 2 and Figure 1). The total machinery investment for this haying arrangement would be about $55,000. These costs are based on new machinery valued at the 1972 price level.

The foregoing comparison indicates much better efficiency and lower costs are attained when using swathers rather than mowers and rakes. Also most ranchers cannot muster a nine-man haying crew, especially when they can get

Table 5. Cost per hour for tractors with varying amounts of annual use.*

Size (dbhp)	Fuel Used	Cost per hour with varying amounts of annual use						
		400	500	600	700	800	900	1,000
100	Diesel	$7.92	$6.99	$6.37	$5.93	$5.62	$5.34	$5.13
80	Diesel	7.54	6.58	5.94	5.49	5.15	4.88	4.67
50	Diesel	3.65	3.27	3.02	2.84	2.70	2.60	2.51
40	Diesel	3.37	2.97	2.71	2.52	2.38	2.26	2.18
30	Diesel	2.78	2.44	2.22	2.06	1.94	1.85	1.78
50	Gas	4.27	3.85	3.57	3.36	3.21	3.09	3.00
40	Gas	3.60	3.24	3.01	2.84	2.71	2.61	2.53
30	Gas	2.93	2.64	2.44	2.30	2.20	2.11	2.05

*Data generated from the survey and from secondary sources.

Abbreviations: dbhp=drawbar horsepower

by cheaper with swathers requiring only a four-man crew.

When less than 1,800 tons of baled hay is harvested, a typical operation might consist of a self-propelled swather, a pto baler pulled by a 40 drawbar hp tractor, and a tractor-mounted front-end loader (Method 3, Table 6). The investment for this machinery is about $28,000. Harvesting 200 tons results in a cost per ton of $14.67; at 800 tons the cost is $7.89; and for 1,600 tons the cost is $7.06 per ton (Figure 2).

In comparison, farmers using two tractor-mounted mowing machines and rakes, but the same type pto baler and front-end loader had a total machinery investment of about $43,500 (Method 4). When only 200 tons were harvested, the cost per ton to harvest and stack the hay was $14.46; at 800 tons the cost reduces to $10.09 per ton; and at 1,600 tons the cost is $9.50 per ton (Table 6). It takes a crew of seven men 31.4 days to harvest 1,600 tons or a total of 220 man days. This comparison indicates that greater efficiency is attained when using swathers instead of mowers and rakes. There is a reduction in cost per ton of 35% when substituting swathers for mowers and rakes when 1,600 tons are harvested ($9.50/$7.06=135%).

A budget was prepared to determine the costs when less than 800 tons are put up annually (Table 6 and Figure 2, Method 5). A typical outfit would include a tractor-mounted mower and a tractor-drawn side rake, a pto tractor-drawn baler, and a tractor-mounted front-end loader. Machinery investment here amounts to about $32,000 (Table 6). With this arrangement, at 200 tons the cost per ton is $13.46 and reduces to $9.93 when 800 tons are harvested. A mower and rake can handle a maximum of about 800 tons in a typical haying season. The budgets show that Method 5 is a rather expensive way of putting up hay, but is the cheapest if only 200 tons are to be harvested. If as many as 800 tons are to be harvested the self-propelled swathers (Method 1 and Method 3) can harvest hay cheaper than mower-rake outfits (Methods 2, 4 and 5).

Harvesting Baled Hay with Balewagons

New Holland Machinery Company, a division of Sperry-Rand, manufactures bale stacking machines of three different sizes. The small size, with a capacity of 3 tons, is propelled by a 50 hp tractor; the medium size of 4½ tons capacity is also propelled by a 50 hp tractor; and the large size, holding 5½ tons is self-propelled. These machines pick up bales from the windrow, stack them on a platform, and transport the bales to a stacking site where they are unloaded automatically. These three balewagons are compared with each other when the hay is baled with a pto baler and with a self-propelled baler. In all six methods a self-propelled swather is used (Table 7).

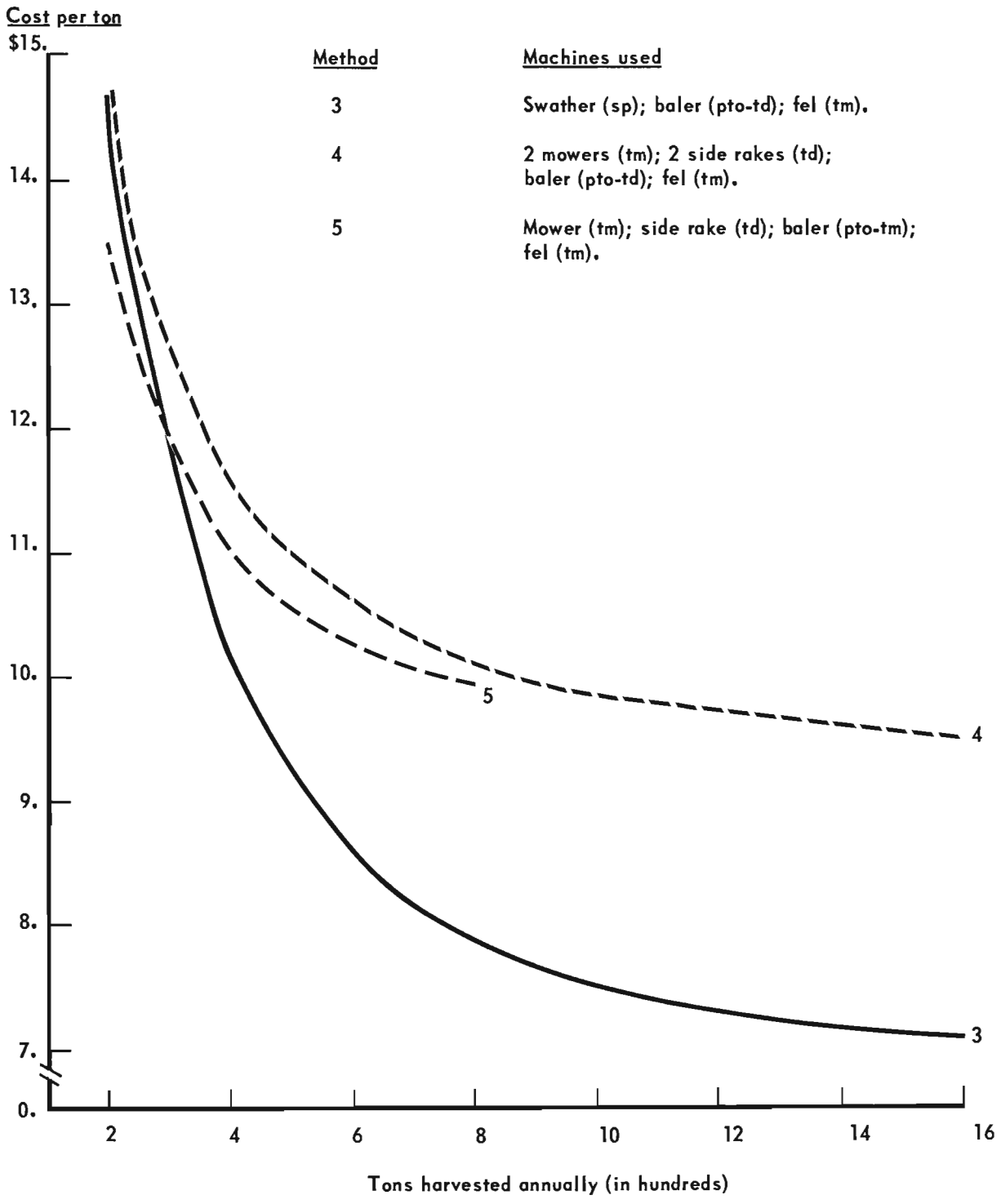


Figure 2. Cost per ton to harvest and stack baled hay – three methods

Table 6. Total cost per ton to harvest and stack baled hay with front-end loaders.

(Comparison of 5 budgets—each with different machinery requirements and each with different labor inputs).

Tons harvested annually	Method 1	Method 2	Method 3	Method 4	Method 5
200	$17.40	$18.24	$14.67	$14.46	$13.46
400	10.97	12.90	10.07	11.51	11.02
600	8.82	11.13	8.53	10.50	10.23
800	7.82	10.23	7.89	10.09	9.93
1,000	7.22	9.72	7.52	9.85	
1,200	6.91	9.39	7.36	9.72	
1,400	6.75	9.25	7.23	9.65	
1,600	6.62	9.12	7.06	9.50	
1,800	6.50	9.04			

Abbreviations: sp=self-propelled; pto=power takeoff; fel=front-end loader; tm=tractor-mounted; td=tractor-drawn.

Description of haying method:

Method	Kinds of machines used	Machinery investment	Crew size	Days* required
1.	Swather (sp); baler (sp); fel (tm)	$27,730	4 men	113
2.	3 mowers (tm); 3 side rakes (td); baler (sp); fel (tm).	54,800	9 men	228
3.	Swather (sp); baler (pto-td); fel (tm).	28,080	4 men	118
4.	2 mowers (tm); 2 side rakes (td); baler (pto-td); fel (tm).	43,460	7 men	220
5.	Mower (tm); side rake (td); baler (pto-td); fel (tm).	31,770	5 men	110

*Number of 10-hour days required for the crew to harvest and stack the maximum tonnage shown for a particular method in the table above.

The small balewagons with a pto baler (Method 1, Table 7) has the lowest harvest cost per ton of all six methods when up to 600 tons are harvested. When from 800 to 1,200 tons are harvested, the small balewagon with a self-propelled baler (Method 2, Table 7) has the lowest cost per ton of all six methods. When 1,400 tons are harvested, Method 2 results in lower cost per ton than Method 1, as well as 15 fewer harvesting days (102 – 87=15 or 5 fewer crew days (15/3 =5).

When as many as 1,400 tons are to be harvested, a large balewagon and a self-propelled baler (Method 6, Table 7) offers the lowest cost per ton of all six methods.

For any given amount of hay, the self-propelled baler is faster than the pto baler. With all six methods, the costs per ton up to 600 tons, are higher when using self-propelled than when using pto balers. When 800 tons are harvested, the use of a self-propelled baler compared to the pto baler results in lower costs per ton for all six methods.

Table 7 indicates that the small and medium sized balewagons are efficient methods of harvesting up to 1,200 tons. When larger tonnages are harvested, the large balewagon and self-propelled baler (Method 6) offer an efficient method of handling quantities of hay rapidly and with a small crew.

Table 7 indicates that if 1,000 tons are harvested, all six methods have similar costs and there is no important cost advantage for any one method. If as many as 1,600 tons are to be stacked, Method 6 with a self-propelled swather, baler, and large balewagon has some advantage.

Picking up and stacking bales with a balewagon is gaining popularity because a small crew can handle a large amount of hay during a normal haying season.

Harvesting Loose Hay with Front-end Loaders

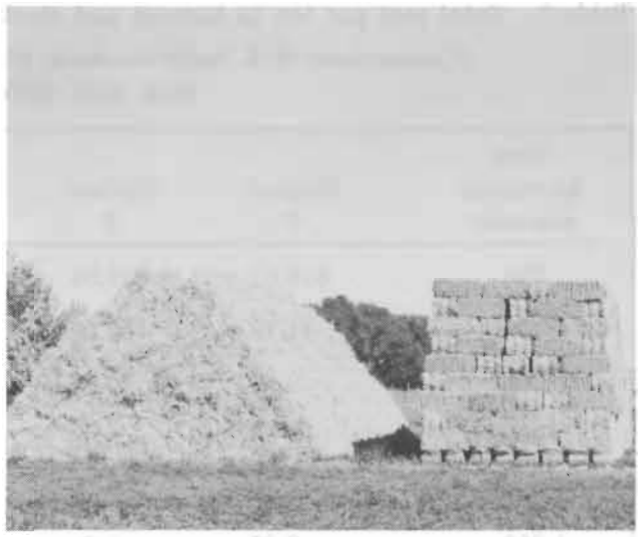
Approximately 15% of Wyoming's hay is stacked loose either with front-end loaders or with Stakhands. Four different methods of loose-stacking hay with front-end loaders are described and discussed briefly.

The least expensive and the most efficient method of stacking 2,400 tons loose can be done with the use of a self-propelled swather, two sweep rakes which are self-contained units, and one tractor-mounted front-end loader (Table 8, Method 1). The sweep rakes consist of a sweep head mounted on an old tractor or mounted on an old truck chassis. This sweep gathers loose hay from the windrows and brings it to the stack area where it is elevated by the use of some kind of tractor-mounted front-end loader.

With haying Method 1 the total machinery investment is less than $25,000 and a four-man crew can harvest 2,400 tons in a 40-day haying period (160/4=40). If only 200 tons are harvested, the cost is $14.45 but reduces to $6 when 1,000 tons are harvested, and to $5.26 when 2,400 tons are harvested.

In comparison, some ranchers who loose stack, still use mowing machines and rakes. A typical set of machinery for a large tonnage consists of three tractor-mounted mowers, three tractor-drawn rakes, two sweep rakes, and one tractor-mounted front-end loader (Table 8, Method 2). This haying arrangement requires an investment of $51,500. The cost per ton ranges from $15.29 when 200 tons are harvested to $7.82 when 2,400 tons are harvested.

In comparison to Method 1, which also harvested 2,400 tons, the machinery investment is more than doubled, and the size of the crew is also more than doubled. The costs at 2,400 tons are likewise about 50% higher ($7.82/$5.26=1.49).



Approximately 80% of Wyoming's hay is harvested as bales and perhaps 90% of the bales are square. Round bales must be stacked in pyramid fashion. Cattlemen located in the Green River Basin and some in Saratoga Valley are experimenting by leaving round bales in the field for feeding. Some weather and feeding loss can be justified if the hay is not moved into and out of the stack.

When 1,200 tons are to be harvested and stacked loose with a front-end loader, a good approach is to use Method 3 (Table 8). Here a self-propelled swather, a sweep rake, and a front-end loader are used, requiring a machinery investment of $21,330 and a three-man crew. The costs per ton range from $13.37 with 200 tons to $6.56 when 1,200 tons are harvested. This is an efficient method of handling a medium quantity of hay. It is not as efficient as Method 1 which requires a larger crew.

When less than 1,000 tons are harvested, an efficient haying outfit consists of one mower, one rake, and one front-end loader (Method 4, Table 8). With this arrangement the haying cost per ton at 200 tons is $8.92, and reduces to $7.25 when 800 tons are harvested. The machinery investment is about $22,000 and a crew of three men is needed.

Harvesting Loose Hay with a Stakhand

The Hesston Machinery Company has, in recent years, developed a machine which goes by the trade-name of "Stakhand". The large machine, Model 60, which handles approximately 5 tons to a load, is powered with a 100 horsepower tractor. The medium size, Model 30, handles 3 tons to a load and is powered by an 80 horsepower tractor. The small size, Model 10, was not found

Table 7. Total cost per ton to harvest and stack baled hay with balewagons.

(Comparison of 6 budgets—each with different machinery requirements and each with different labor inputs).

Tons harvested annually	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6
200	$16.61	$19.34	$18.35	$21.08	$22.55	$25.28
400	11.19	12.09	11.97	12.87	13.73	14.63
600	9.50	9.79	9.83	10.12	10.81	11.10
800	8.87	8.80	9.10	9.03	9.47	9.40
1,000	8.45	8.15	8.67	8.37	8.68	8.38
1,200	8.25	7.80	8.44	7.99	8.38	7.93
1,400	8.14	7.66	8.26	7.78	8.11	7.63
1,600			8.04	7.60	7.85	7.41
1,800						7.24
2,000						7.16
2,200						7.02
2,400						6.96

Abbreviations: sp=self-propelled; pto=power takeoff; fel=front-end loader; tm=tractor-mounted; td=tractor-drawn.

Description of haying method:

Method	Kinds of machines used	Machinery investment	Crew size	Days* required
1.	Swather (sp); baler (pto-td); small balewagon (pto-td).	$30,430	3 men	102
2.	Swather (sp); baler (sp); small balewagon (pto-td).	30,080	3 men	87
3.	Swather (sp); baler (pto-td); medium balewagon (pto-td).	33,430	3 men	107
4.	Swather (sp); baler (sp); medium balewagon (pto-td).	33,080	3 men	89
5.	Swather (sp); baler (pto-td); large balewagon (sp).	32,900	3 men	93
6.	Swather (sp); baler (sp); large balewagon (sp).	32,550	3 men	114

*Number of 10-hour days required for the crew to harvest and stack the maximum tonnage shown in the table above.

in the State. The Stakhand picks up loose hay from windrows and distributes it into a power-operated compression chamber. When the chamber becomes full, the operator stops and compresses the hay with an hydraulic driven packer. This operation continues until a loaf-like stack is formed. To unload, the operator opens the end-gate, engages the push-off lever, and eases out from under the load. The stack can be unloaded in the field, or can be transported several miles to a stackyard. With a stack retriever, the stack can also be re-loaded and moved to another location.

Haying machinery for a large tonnage using Stakhands involves: a self-propelled swather and a large size Model 60 Stakhand drawn by a 100 horsepower tractor. These represent a machinery investment of $37,176 and require a two-man crew. In 44 days this crew can put up 2,400 tons (Table 9, Method 1). When 200 tons are harvested, the cost per ton is $18.72; when 1,000

Table 8. **Total cost per ton to harvest and stack loose hay with front-end loaders.**

(Comparison of 6 budgets—each with different machinery requirements and each with different labor inputs).

Tons harvested annually	Method 1	Method 2	Method 3	Method 4
200	$14.45	$15.29	$13.37	$8.92
400	9.08	11.01	9.05	7.70
600	7.33	9.64	7.61	7.35
800	6.49	8.90	7.03	7.25
1,000	6.00	8.50	6.71	
1,200	5.75	8.23	6.56	
1,400	5.58	8.08		
1,600	5.47	7.97		
1,800	5.35	7.89		
2,000	5.29	7.84		
2,200	5.26	7.82		
2,400	5.26	7.82		

Abbreviations: sp=self-propelled; fel=front-end loader; tm=tractor-mounted; td=tractor-drawn.

Description of haying method:

Method	Machinery investment	Crew size	Days* required
1. Swather (sp); 2 sweep rakes (sp); fel (tm).	$24,430	4	160
2. 3 mowers (tm); 3 side rakes (td); 2 sweep rakes (sp); fel (tm).	51,500	9	314
3. Swather (sp); sweep rake; fel (tm).	21,330	3	99
4. Mower (tm); side rake (td); fel (tm).	21,920	3	94

*Number of 10-hour days required for the crew to harvest and stack the maximum tonnage shown in the table above.

tons, the cost per ton is $7.03 per ton; and $5.84 when 2,400 tons are harvested.

Although not widely used in Wyoming at present, the Model 30 Stakhand tends to be an efficient machine for the farmer who has a limited amount of capital and who has limited haying tonnage. When 200 tons are harvested with a Model 30 Stakhand, the cost per ton is $16.56, and reduces to $8.31 when 1,000 tons are harvested (Table 9, Method 2). The investment in machinery for the swather, Model 30 Stakhand and the 80 horsepower tractor is $29,250, compared to $37,176 when the larger Stakhand is used. An operator who has limited capital might consider using the Model 30 Stakhand. If he has 600 tons to put up, however, it can be harvested cheaper with the larger sized machine.

Harvesting Haylage

Hay is usually cut with a swather and allowed to wilt in the windrow down to about 50% moisture when producing haylage. The haylage is then chopped by the forage chopper and hauled by trucks to a trench-type silo. A tractor with a blade is used to pack the haylage. Wheel type tractors are more popular, and they do a better job of packing than the crawler type. To reduce

Table 9. Total cost per ton to harvest and stack loose hay with Stakhand.

(Comparison of 2 budgets—each with different machinery requirements and each with different labor inputs).

Tons harvested annually	Method 1	Method 2
200	$18.72	$16.56
400	11.36	11.10
600	8.88	9.37
800	7.71	8.78
1,000	7.03	8.31
1,200	6.63	
1,400	6.44	
1,600	6.36	
1,800	6.22	
2,000	6.09	
2,200	6.00	
2,400	5.84	

Abbreviations: sp=self-propelled; pto=power takeoff; td=tractor-drawn.

Description of haying method:

Method **Kinds of machines used**

1. Swather (sp); large Stakhand (pto-td).
2. Swather (sp); medium Stakhand (pto-td);

Method	Machinery investment	Crew size	Days* required
1.	$37,176	2	88
2.	29,250	2	57

*Number of 10-hour days required for the crew to harvest and stack the maximum tonnage shown in the table above.

loss the filled silo is frequently covered with a plastic sheet weighted with discarded automobile tires or covered in some other manner.

Two budgets were prepared to represent the cost of harvesting alfalfa as haylage. The first includes a self-propelled swather, a self-propelled forage harvester, a tractor-mounted blade, and

Table 10. Total cost per ton to harvest and stack haylage hay with pto and sp harvesters.

(Comparison of 2 budgets—each with different machinery requirements and each with different labor inputs).

Tons harvested annually	Method 1	Method 2
200	$19.10	$15.79
400	11.35	11.43
600	8.96	9.98
800	7.81	8.85
1,000	7.13	8.21
1,200	6.74	7.86
1,400	6.58	7.68
1,600	6.37	7.52
1,800	6.23	
2,000	6.11	
2,200	6.02	
2,400	5.93	

Abbreviations: sp=self-propelled; pto=power takeoff; m=tractor-mounted; td=tractor-drawn.

Description of haying method:

Method

1. Swather (sp); forage harvester (sp); blade (tm); 2 trucks.
2. Swather (sp); forage harvester (pto-td); blade (tm); 2 trucks

Method	Machinery investment	Crew size	Days* required
1.	$30,180	5	185
2.	34,180	5	181

*Number of 10-hour days required for the crew to harvest and stack the maximum tonnage shown in the table above.

two trucks (Table 10, Method 1). This requires a machinery investment of about $30,000. A five-man crew can harvest 2,400 tons in 37 days (185/5=37).

This Stakhand, powered by a 100 hp tractor, picks up windrowed hay, compresses it into 4-5 ton loaf-like stacks and unloads mechanically. Designed for loose hay handling, the new cost of this Stakhand and tractor is about $26,000.

Haylage, in these budgets, is computed in terms of alfalfa hay equivalent. To estimate total tons of green haylage, multiply the tons harvested in Table 10 by 1.8 (90/50=1.8). This is the tons of green haylage (50% dry matter) that must be hauled to make the tons of alfalfa hay equivalent indicated. If 200 tons of alfalfa equivalent are harvested, the cost per ton is $19.10. If 1,000 tons are harvested, the cost reduces to $7.13 per ton, and to $5.93 per ton when 2,400 tons are put up (Table 10).

The second budget compares costs when a pto harvester is substituted for a self-propelled unit. Method 2 includes a self-propelled swather, a pto forage harvester, a tractor-mounted blade, and two trucks. This investment amounts to about $34,000 and a five man crew is required (Table 10). If 200 tons of alfalfa hay equivalent, or 360 tons of haylage, are harvested, the cost is $15.79 per ton of hay equivalent. If 1,000 tons

Most Wyoming hay is harvested with a swather which cuts and windrows. An attached conditioner flattens alfalfa and clover stems which permit faster drying. Conditioners are seldom used with native hay and never with ripening grain.

Table 11. **Total cost per ton to harvest and stack hay with a self-propelled cuber.**

Tons harvested annually	Method 1
200	$41.31
400	22.78
600	16.59
800	13.57
1,000	11.74
1,200	10.62
1,400	9.78
1,600	9.47
1,800	9.28
2,000	9.26
2,200	9.12
2,400	9.07

Abbreviations: sp=self-propelled; pto=power takeoff; tm=tractor-mounted.

Description of haying method:

Method: 1
Kinds of machines used: Swather (sp); cuber (sp); elevator (pto-tm); truck

Machinery investment: $47,500
Crew size: 3
Days required*: 155

*Number of 10-hour days required for the crew to harvest and stack the maximum tonnage shown in the table above.

of alfalfa equivalent are to be harvested, the cost per ton would be $8.21.

Harvesting Cubed Hay with a Mobile Cuber

Cubing alfalfa and other legume hay was introduced into Wyoming in 1965 when a John Deere 400 Hay Cuber was brought to the Riverton area from Nebraska. Since that time, the number of cubers in Wyoming has increased to 21 for the 1971 harvesting season. Alfalfa or legume hay is the chief type suitable for cubing, but a small amount of grass may also be present. Hay is cut with a swather and conditioner and permitted to dry in the windrow for several days, or if humidity is high, up to a week.

A mobile cubing unit picks up the loose hay with a front-end attachment. The hay is then ground and compressed and forced through dies. Hay emerges in the form of cubes approximately 1¼ x 1¼ x 2½ inches. Hay is sprayer with about 10% by weight of water while it is being picked up. The dried hay must be moist as it enters the chopping unit. Moisture permits the mucilaginous substance on the stems and leaves of the legume hay to form under pressure into a tight cube. If insufficient water or too much grass is in the sample, the cubes break and do not stick well.

Using the basic data generated from this economic study, a budget was prepared which includes one self-propelled swather, one self-propelled cuber, an elevator, and a truck. This investment is about $48,000, and a three-man crew is required (Table 11). When 200 tons are cubed annually, the cost is $41.31 per ton. This cost reduces to $11.74 per ton when 1,000 tons are cubed, and at 2,400 tons the cost is $9.07.

Summary of Synthetic Budgets

A summary of six synthetic budgets is presented (Table 12). These show for various tonnages, cost per ton to harvest, and stack several kinds of hay.

The least expensive way to harvest hay is with a self-propelled swather and two sweep rakes. It is then stacked loose with a front-end loader (Table 12, Method 1, Fig. 3). When 200 tons are harvested annually, the cost is $14.45 per ton; at 1,000 tons $6; and reduces to $5.26 per ton for 2,400 tons. The machinery investment is about $24,500, a four-man crew is required and a total of 80 ten-hour days or 20 harvest days for the crew are required to harvest 1,200 tons.

Harvesting loose hay with a self-propelled swather and a large Stakhand, Method 4, is the next cheapest method, but depending on the tonnage harvested, costs range from $.58 - $4.27 more per ton than Method 1 (Table 12). Using the Stakhand increases the machinery investment about 50% over using front-end loaders but the crew is reduced to two men who require 22 haying days to harvest 1,200 tons. If time is of the

Table 12. Cost per ton to harvest and stack loose, baled, haylage and cubed hay.

Annual tonnage	Kind of hay: Loose	Baled	Baled	Loose	Haylage	Cubed
	Method: 1	2	3	4	5	6
200	$14.45	$17.40	$25.28	$18.72	$19.10	$41.31
400	9.08	10.97	14.36	11.36	11.35	22.78
600	7.33	8.82	11.10	8.88	8.96	16.59
800	6.49	7.82	9.40	7.71	7.81	13.57
1,000	6.00	7.22	8.38	7.03	7.13	11.74
1,200	5.75	6.91	7.93	6.63	6.74	10.62
1,400	5.58	6.75	7.63	6.44	6.58	9.78
1,600	5.47	6.62	7.41	6.36	6.37	9.47
1,800	5.35	6.50	7.24	6.22	6.23	9.28
2,000	5.29	6.40	7.16	6.09	6.11	9.26
2,200	5.26	6.30	7.02	6.00	6.02	9.12
2,400	5.26	6.20	6.96	5.84	5.93	9.07

Abbreviations: sp=self-propelled; pto=power takeoff; fel=front-end loader; tm=tractor-mounted; td=tractor-drawn.

Description of haying methods:

Method	Kind of hay stacked and machines used	Machinery investment	Crew Size	Crew Days	Total days required*
1	Loose: swather (sp) ; 2 sweeprakes (sp) ; fel (tm).	$24,430	4	20.0	80
2	Baled: swather (sp) ; baler (sp) ; fel (tm).	27,730	4	14.1	56
3	Baled: swather (sp) ; baler (sp) ; large balewagon (sp).	32,550	3	19.0	57
4	Loose: swather (sp) ; large Stakhand (pto-td).	37,176	2	22.0	44
5	Haylage: swather (sp,; forage harvester (sp) ; blade (tm) ; 2 trucks.	30,180	5	18.4	92
6	Cubes: swather (sp) ; cuber (sp) ; elevator (pto-tm) ; truck.	47,500	3	26.0	78

*Total number of 10-hour days required to harvest and stack 1,200 tons.

essence one finds the large Stakhand a satisfactory way to put up hay with a two-man crew.

It costs more to bale the hay than to stack it loose. Method 2, using a self-propelled swather, a self-propelled baler, and a front-end loader requires a machinery investment of about $28,000. Also required is a crew of four men to work a total of 56 10-hour days or 14.1 crew days to harvest 1,200 tons. Using a self-propelled swather, a self-propelled baler, and a large balewagon increases the machinery investment to about $32,-500 but reduces the crew size by one man and reduces the haying period by several days (Table 12, Method 3, Fig. 3).

Haylage harvested with a self-propelled swather, a self-propelled forage harvester, a tractor-mounted blade, and two trucks (Method 5) can be harvested cheaper than baled hay with a balewagon, (Method 3) and about as cheaply as baled hay with a front-end loader (Method 2). An investment of about $30,000 and a crew of five men are required for harvesting haylage. The crew works a total of 92 10-hour days or 18.4 days in the haying field (92/5=18.4).

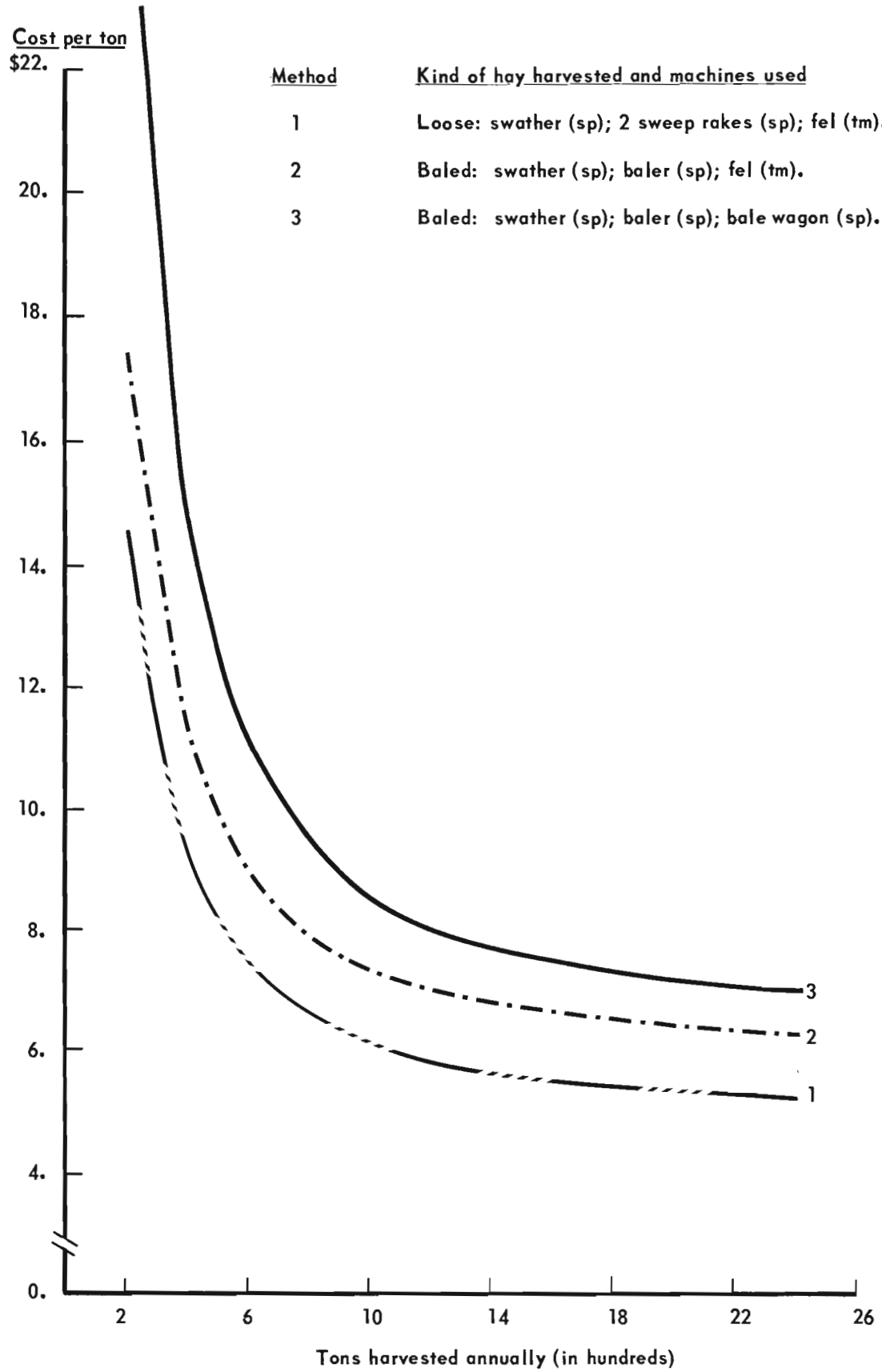


Figure 3. Cost per ton to harvest and stack hay using three different methods (Loose: fel; Baled: fel; Baled: large bale wagon)

Haylage (hay wilted to about 50% moisture and then ensiled), placed in a feed mixer by a front end loader, is mechanically augered into feed bunks.

Cubing is the most expensive of the six methods of harvesting hay (Table 12, Method 6, Figure 4). A self-propelled swather, a self-propelled cuber, an elevator, and a truck requires a total investment of about $48,000. The crew of three men to harvest 1,200 tons, work a total of 78 10-hour days, which requires about 26 days of good haying weather.

This self propelled mobile cubing unit requires an investment of about $40,000. In addition, a truck to haul cubes and another to haul water is needed. A ton of hay after being thoroughly dried in the windrow is sprayed with about 200 pounds of water as it is picked up. After grinding, the hay is forced through dies which result in cubes approximately 1¼x1¼x2½ inches. The loaded cart is raised hydraulically and the cubes dumped into a truck.

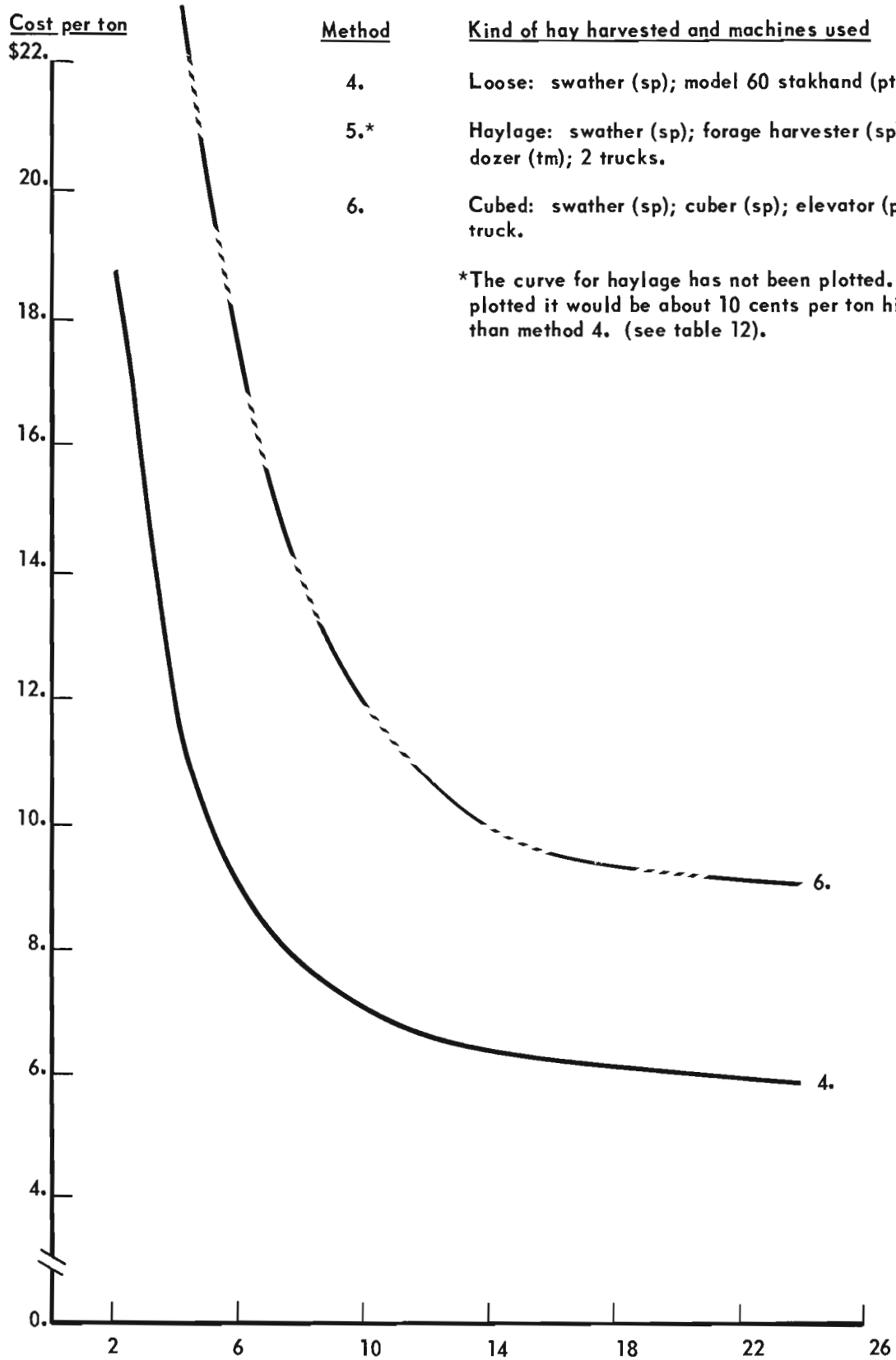


Figure 4. Cost per ton to harvest and stack hay using two different methods. (Loose: large Stakhand; haylage (not plotted), cubed.)

BUDGETS FOR VARIOUS METHODS OF STORING AND FEEDING HAY

Basic Data

Budgets were prepared showing the cost of storing and feeding various kinds and amounts of hay. In budgeting these costs consideration was given to the amount of hay fed per day, the machines used, distances traveled, practices followed, and length of feeding time required daily. Some cost components generated in the foregoing analysis and information from secondary sources was used in budget preparation. Only the most common feeding and storing situations could be budgeted.

The costs of storing, feeding, and harvesting hay should help farmers and ranchers decide which method of storing, feeding, and harvesting hay is best suited for their particular farm or ranch operations.

Storage Costs

Costs of storing hay considered herein are of two types: 1) the costs of preparing and maintaining fenced yards for protection of hay, and 2) the loss incurred due to spoilage by snow and rain. A charge for interest on investment while hay is in storage was ignored. It was assumed that the different kinds of hay would be in storage about the same length of time.

There is a wide range of climatic conditions in Wyoming. Storage losses of hay due to weather are higher in the 16-20 inch area than where precipitation is 8-16 inches annually. Much of Wyoming's irrigated alfalfa hay is produced where there is less than 16 inches of annual precipitation. Storage losses due to weather in these areas are relatively small.

In estimating storage losses, cooperating farmers and ranchers were asked: Under normal conditions for your area, what percentage of each stack is lost during storage? For example, if bales are stacked nine high, how much loss do you have on the bottom tier, on the top tier, and in the cracks near the top? Farmers answered this question by saying they lose about 6, 8, or 10 inches at the bottom and 2, 4, or 6 inches of the top tier. Although partly spoiled, this hay

It is becoming a common practice to provide shelter for baled hay in areas of heavy snowfall.

is fed. It was estimated that partly spoiled hay retained about 50% of the nutritive value.

When hay is stacked on damp, low-lying meadow land, a larger loss is expected than when it is stacked on a knoll or some higher elevation where the wind removes more of the snow. For baled hay the percentage of complete loss due to storage ranged from 2% to 8%, and averaged 4.5%. For loose hay the loss ranged from 2 to 6% and averaged 3.5%. The average loss for cubed hay was 2.5%, and for haylage the loss in storage was 12.5%. These losses apply to areas receiving less than 16 inches of annual precipitation. The losses are believed to be somewhat higher in the high mountain valleys, and in the western part of Wyoming where the annual precipitation exceeds 16 inches.

Storage costs also include annual expenses for repairing and maintaining stack yards. A given tonnage of hay requires less stack yard fence when stacked as bales than when stacked as loose hay. Baled hay requires considerably more fence than alfalfa cubes which are usually stacked in the open and protected only with a wire fence. Likewise, loose hay stacked in 5-ton stacks with a Stakhand required more fence than when stacked loose in 20-30 ton butts. Baled hay stacked in long narrow ricks with a balewagon requires slightly more fence than when bales are placed in larger stacks with a front-end loader and arranged manually. Haylage in a trench silo with a concrete floor and earthen sides has, in comparison to stacked hay, a large loss in storage as well as a higher cost for ownership, repair and maintenance of the storage facility.

Many different stack yards were measured and estimates were made of the tons of hay in each. From these measurements, budgets were prepared considering the number of gates and the rods of 5-wire fence required for various tonnages and kinds of hay. Normally hay is stacked in yards which contain from 50-100 tons per yard. Because of the relatively uniform amount of hay in each yard, the fencing cost per ton for a particular kind of hay is about the same when 200, 1,000, or 2,000 tons are stored annually. The storage costs per ton, including the use of storage facilities, as well as loss due to weather, for the various kinds of hay are shown in the following tabulation.

This warm-up or over-wintering feeding arrangement consists of alfalfa cubes placed in a tall stack with an inexpensive elevator near self-feeders. With a tractor mounted front-end loader, in only a few hours, one man can place enough cubes in the self-feeders to feed 500 calves one week.

This rick of hay is approximately 800 feet long and has been stacked on a dry knoll. More efficient stack arrangements could be made if four ricks, each 200 feet long, had been stacked side by side.

Kind of hay and method of stacking	Value per ton	Percentage loss due to weather	Annual storage cost per ton		
			Weather loss	Use of storage facility	Total storage cost
Cubes					
with elevator	$30	2.5	$ .75	$.05	$ .80
Loose					
with fel	20	3.5	.70	.20	.90
with Stakhand	20	3.5	.70	.30	1.00
Baled					
with fel	25	4.5	1.02	.10	1.22
with balewagon	25	4.5	1.12	.13	1.25
Haylage, trench silo with concrete floor and earthen sides	10	12.5	1.25	.40	1.65*

*This cost is for 400 tons which, due to more efficiency in use of the trench silo, reduces to $1.45 when 2,000 tons are stored.

Feeding Costs

The cost of feeding hay is influenced by the tons fed per hour and the investment in and the cost of owning and operating the various machines used in the feeding operation. These costs in turn are influenced by wear-out life of the machine and such things as the repair cost per hour, the fuel cost per hour, and still other factors. The rate fed per hour is influenced by the amount of hay fed per day, the distance traveled, and the speed of travel. For all feeding operations labor was computed at a cost of $2 per hour. The synthesized budgets represent the most common feeding situations.

The cost per ton for feeding the various kinds and amounts of hay is shown in Table 13 and is presented graphically in Figure 5.

The reader should bear in mind that the costs in this table do not include the loss due to waste in feeding. For example, there is more waste due to non-consumption of stems and due to loss of leaves when loose or baled hay is fed than when cubes or haylage are fed. Since these loss differences are difficult to quantify, they were ignored when budgeting the cost of feeding hay.

Baled Hay

Baled hay fed from a flatbed truck at the rate of 1.6 tons per hour has a feeding cost per

Much baled hay in Wyoming is stacked in 30-60 ton butts in the feed yard area. When one or two tiers of bales have been fed, these inexpensive mobile feedbunks can be moved toward the center so the next tier can be fed with a shorter lateral movement.

Photo courtesy Jack Richards Studio, Cody, Wyo.

Table 13. Cost per ton to feed various kinds and amounts of hay.

	Tons fed annually									
	200	400	600	800	1000	1200	1400	1600	1800	2000
Kind of hay fed										
Haylage (fel-mixer box)	$4.87	$3.30	$2.87	$2.72	$2.63	$2.56	$2.50	$2.45	$2.40	$2.38
Alfalfa cubes (fel-truck)	3.24	1.94	1.52	1.32	1.19	1.11	1.07	1.04	1.02	1.00
Loose hay (grapple fork-hayrack)	4.00	2.93	2.60	2.46	2.40	2.37	2.33	2.29	2.28	2.27
Loose hay (stack mover-feeder)	7.68	5.08	4.22	4.01	3.86	3.76	3.67	3.58	3.50	3.43
Baled hay (flatbed truck)	5.58	4.12	3.64	3.51	3.43	3.37	3.31	3.27	3.24	3.20
Baled hay (stack mover)	5.28	3.71	3.18	3.10	2.91	2.89	2.83	2.79	2.75	2.72

Tractor drawn or self-propelled bale wagons are popular because one man can stack 60-80 tons per day. The same load stacked at harvest time can be picked up in winter and hauled to the feeding area with this bale wagon.

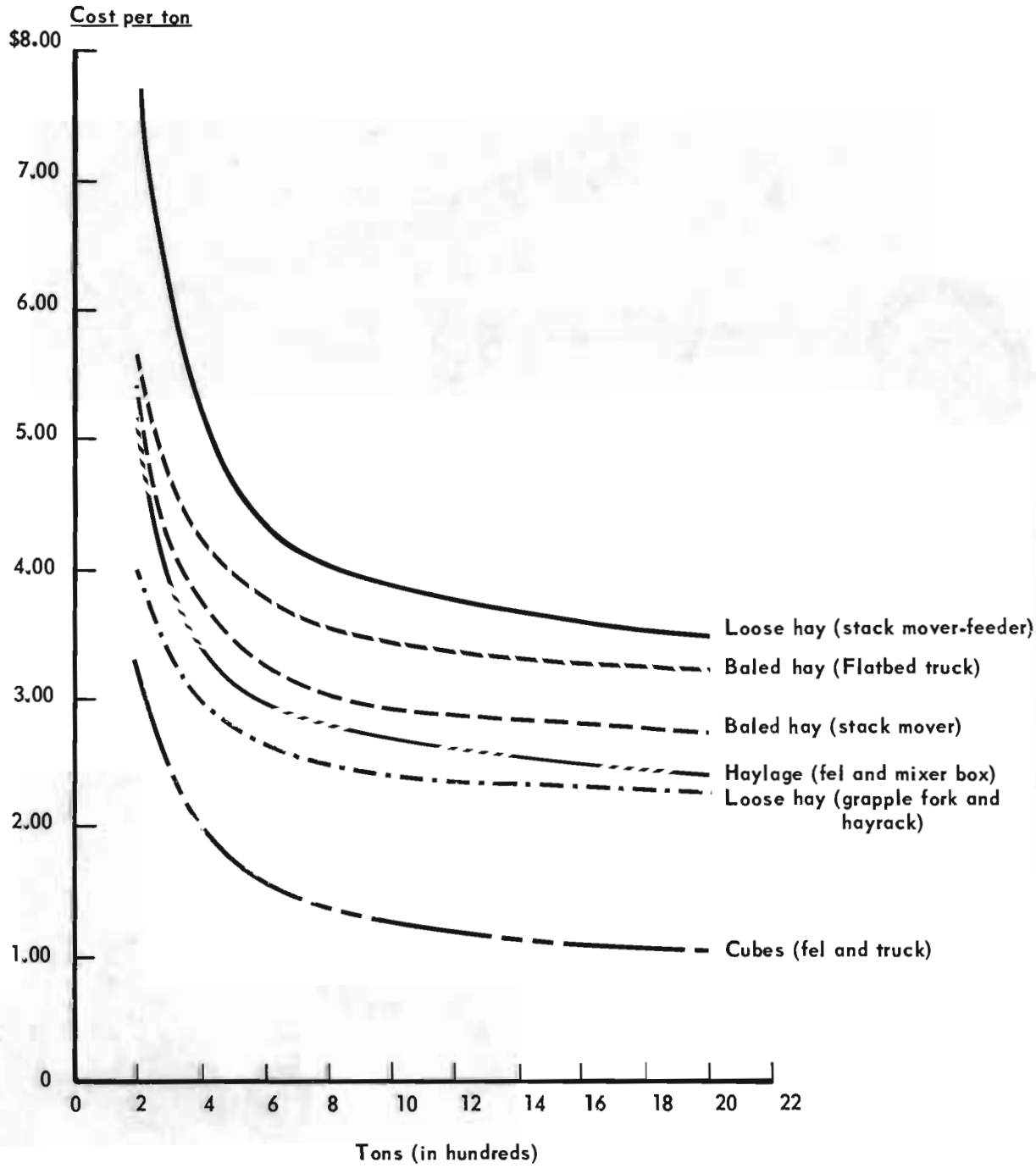


Figure 5. Cost per ton to feed various kinds and amounts of hay

Bales picked up from the field by an elevator attached to the truck side must be loaded manually. The same load which is harvested can, in winter, be mechanically picked up and transported as far as necessary for feeding.

ton which ranges from $5.58 when 200 tons are fed to $3.43 when 1,000 tons are fed, and $3.20 when 2,000 tons are fed (Table 13, Figure 5). The machinery investment is $5,000, wear-out life 6,000 hours, and fuel and repair cost each are $1 per hour. This is a two-man operation.

Baled hay stacked with a balewagon and fed with mechanized stack-mover at the rate of 2 tons per hour has an annual feeding cost of $5.28 per ton when 200 tons are fed (Table 13, Figure 5). The cost is $2.91 per ton when 1,000 tons are fed, and $2.72 when 2,000 tons are fed per year. In this operation one man drives the truck and the other cuts the twine or wire and scatters the hay. The stack-mover investment is $6,000, the wear-out hours are 2,500, repairs and fuel costs are each at the rate of $1 per hour.

This grapple fork mounted on a self-propelled hydraulically operated stacker is a handy and efficient feeding arrangement. Two or three 800-pound forks full can be fed from a hay rack or the hay can be dribbled out to the livestock by shaking the fork.

Loose Hay

Loose hay fed with a grapple fork mounted on a tractor or truck chassis, and a hayrack, has an investment requirement of $4,000, repair cost of $1 per hour, fuel consumption rate of $1 per hour, feeding rate of 2.25 tons per hour, and wear-out life of 6,000 hours. Under these con-

ditions the feeding cost per ton is $4 when 200 tons are fed per year, $2.40 when 1,000 tons are fed, and $2.27 when 2,000 tons are fed (Table 13, Figure 5).

Loose hay stacked with a Stakhand and mechanically fed with a stack-mover and stack-feeder arrangement requires only one man who feeds 3 tons per hour. The machinery investment is $8,600. The wear-out life is 3,000 hours, repair costs are $2.30 per hour, and the use of a tractor which pulls the stack mover-feeder is $2 per hour. Under these conditions the feeding cost is expensive when only 200 tons are fed annually—$7.68 per ton. The cost is $3.86 per ton when 1,000 tons are fed, and $3.43 when 2,000 tons are fed (Table 13, Figure 5). Some large ranches with limited winter help use this type of operation.

Cubes

The cheapest method of feeding hay is in the form of cubes. A front-end loader mounted on a tractor loads the cubes into a truck, and hay is fed at the rate of 8 tons per hour. The investment is $5,000, the wear-out life is 2,500 hours, repair costs are $1.50 per hour, and the fuel cost is $1.25 per hour. When 200 tons are fed per year the feed cost per ton is $3.24. The cost is $1.19 per ton when 1,000 tons are fed, and $1 per ton when 2,000 tons are fed (Table 13, Figure 5).

Haylage

Feeding haylage is entirely mechanized and is one of the least expensive feeding methods. Baled or loose hay is usually ground before going to the feedlot but haylage is ready to load and feed through a feed truck. The tons of "alfalfa equivalent" are fed at the rate of 4 tons per hour, the investment in the augered mixer box is $6,000, the wear-out life is 2,500 hours, and the repair and fuel costs are each $1.25 per hour. The cost of operating the front-end loader and tractor which load the haylage into the mixer box are computed at the rate of $1.50 per hour. Under these assumptions, when 200 tons are fed annually the cost per ton is $4.87, and reduces to $2.63 when 1,000 tons are fed, and to $2.38 when 2,000 tons are fed (Table 13, Figure 5).

This stack mover-stack feeder picks up a loaf-like stack and transports it to the feeding area. The sliced hay then falls on a conveyor belt which distributes it to the feeding area. This system requires an investment in the stack feeder-stack mover and in the large tractor of about $18,000. However, with the equipment, one man can feed 1,000 head of cattle, 10 tons of hay in about two hours.

APPENDIX--COMPONENTS OF HAY HARVESTING COSTS IN WYOMING

Harvesting Baled Hay

Baled hay is the most popular method of harvesting hay in the United States. In 1967 baled hay represented 90% of all the hay harvested in the U.S. and 83% of the hay harvested in Wyoming.[1] The hay handling methods in Wyoming differed mainly in the way bales are stacked—one method used a front-end loader, another used a pull-type balewagon, and still another method used a self-propelled balewagon.

Front-End Loader

Harvesting baled hay with a front-end loader involves swathing and baling the hay. Bales are then transported to the stack area by a sweep rake, or by a loader, and placed on a stack by the loader where they are arranged manually.

[1] Hay Harvesting Practices and Labor Used 1967-48 States; ERS and Statistical Reporting Service, USDA. Statistical Bul. No. 460, Jan. 1971.

When bales are to be handled manually, they are generally put up in 50-60 pounds weights. When they are to be picked up with a bale wagon an 80-90 pound bale is required for efficient handling.

Schedules were obtained from 34 farms and ranches. Nine were located in the Cokeville area, eight in the Lander-Riverton-Pavillion area, five in the Baggs-Dixon area, four in the Lyman-Evanston area, and the remainder were scattered throughout the state. A total of about 50,000 tons were harvested by these operators. Most of the farmers raise beef cattle and had some type of feeder cattle operation. The rest grazed sheep. Native hay and alfalfa hay were raised by about the same number of operators, but native hay had a much higher acreage.

All of the operators used swathers to place the hay in windrows, and they used sweeprakes to transport the bales to the stack area. The total harvesting cost per ton was $9.03, with $4.11 being fixed costs (Table1). Labor was the second largest cost item, and all other variable costs made up the balance of $2.59 per ton. The average farm harvested 1,430 tons with an average yield of 2.77 tons per acre. The average machinery investment was $28.97 per ton and the labor efficiency was .95 tons per man hour.

The nine lowest cost farmers had an average harvest cost of $6.28 per ton and harvested 2,820 tons per farm. The hay yielded 2.20 tons per acre, and was harvested at the rate of 1.83 tons per man hour, with a machinery investment of $16.89 per ton. In comparison, the high-cost group had an average cost of $11.49 per ton, and harvested only 573 tons per farm. This group had a machinery investment per ton of $42.88, and had lower labor efficiency—.83 tons per man hour. This comparison shows that the amount of machinery investment per ton and tons harvested per man hour both have important influences on total cost per ton.

Balewagon

Data were collected from 34 operators in 11 counties who used balewagons. Fifteen were located in the Baggs-Dixon-Saratoga area of Carbon County, seven were located in Goshen County, and the remainder were widely scattered. These 34 farms were harvesting about 48,000 tons, or an average of 1,400 tons per farm with an average crew of three men. About 91% of the hay was harvested for home use, and 9% was done

Table 1. Components of costs when stacking baled hay with front-end loaders. (Comparing low-cost and high-cost operators—34 Wyoming farms, 1971).

	Ave. for 25% with:		Averages for all 34 farms
	Lowest cost	Highest cost	
Average harvesting cost per ton			
Fixed cost	$ 2.33	$ 6.06	$ 4.11
Variable cost			
Labor	1.78	2.53	2.33
All other	2.17	2.90	2.59
Total harvesting costs	6.28	11.49	9.03
Organizational factors			
Machinery investment per ton	16.89	42.88	28.97
Tons harvested per man hour	1.83	.83	.95
Average yield per acre (tons)	2.20	3.15	2.77
Tons harvested per farm	2,820	573	1,430

on a custom basis. About 82% of the operators raise beef cattle, while 85% raised some type of feeder cattle, most of which were heifer replacements for the beef herd. Although only 15% of the farms produced sheep, some 24,000 head were being raised.

The average harvesting cost per ton for the 20 farmers using self-propelled balewagons was $7.23, and was $7.87 per ton for the 14 farmers using pull-type machines (Table 2). The group using the self-propelled machines was harvesting more tons per farm resulting in lower machinery investment, and lower fixed costs per ton.

Harvesting Loose Hay

About 15% of all hay raised in Wyoming in recent years was put up loose, either with front-end loaders or with Stakhands.

Front-end Loaders

Harvesting loose hay with front-end loaders involves mowing and raking the hay or swathing into large windrows. Hay is then swept to the stack area where it is elevated and stacked with some type of front-end loader, usually without a man on the stack.

Table 2. Components of costs when stacking baled hay with balewagons. (Comparing self-propelled with pull-type balewagons—34 Wyoming farms, 1971).

	20 Self-propelled	14 Pull type
Average harvesting cost per ton		
Fixed cost	$ 3.51	$ 3.97
Variable cost		
Labor	1.32	1.38
All other	2.40	2.52
Total harvesting costs	$ 7.23	$ 7.87
Organizational factors		
Machinery investment per ton	$20.40	$27.20
Tons harvested per man hour	1.60	1.72
Average yield per acre (tons)	2.75	2.86
Tons harvested per farm	1,732	934

When the yield is light, two windrows are frequently moved together to increase efficiency in handling.

Thirty-six operators were interviewed from seven different counties. Twelve were located in Sublette County in the Big Piney-Pinedale-Boulder area; eight were located in Uinta County around Evanston-Lyman area; seven were in Carbon County around Baggs and Dixon; and five were in Teton County near Jackson. The remainder were scattered in several other areas. These operators harvested about 40,000 tons for an average of 1,110 tons per operation with an average crew of seven men.

All 36 operators raised beef cattle and kept some feeder cattle mainly for replacement to the cow herd; 6% also raised sheep. About 94% grew native, and 8% produced alfalfa hay.

Table 3. Components of costs when stacking loose hay with front-end loaders. (Comparing mowers and side rakes with swathers—29 Wyoming farms, 1971).

	Mowers and rakes	Swathers
Average harvesting cost per ton		
Fixed cost	$ 2.76	$ 3.56
Variable cost		
Labor	3.58	1.87
All other	1.72	1.76
Total harvesting costs	$ 8.06	$ 7.19
Organizational factors		
Machinery investment per ton	$19.25	$23.86
Tons harvested per man hour	.59	1.12
Average yield per acre (tons)	1.41	1.50
Tons harvested per farm	1,163	893

The average cost of harvesting loose hay with a front-end loader was $8.06 per ton when using mowers and rakes, and $7.19 per ton when using swathers (Table 3).

The use of swathers required a higher machinery investment per ton, which resulted in higher fixed costs per ton. Operators using swathers harvested at the rate of 1.12 tons per hour, compared to .59 tons for the group using mowers. Labor costs per ton were $1.87 for those swathers, compared to $3.58 per ton for those using mowers. Most operators using mowers said they planned to change to swathers when the mowers were worn out, and when new hay cutting machinery was required.*

* The following formula shows the number of acres covered by a machine in a ten-hour day: Speed (miles per hour) times width (in feet). For example, a 12 foot swather traveling 3.5 miles per hour would cover 42 acres in 10 hours (12x 3.5=42). This formula assumes 17.5% "down time", or time lost in turning and servicing the machine.

Stakhand

In 1971, 34 Stakhands were in use in Wyoming. Seven were in Sheridan County, five in Goshen County, five in the Cokeville area and the remainder were scattered. These 34 operators were harvesting about 45,000 tons per year or an average of 1,321 tons per farm with an average crew of two men.

About 71% of the operators raised beef cattle and feeder cattle while 9% raised sheep and 12% fed lambs. About 59% put up alfalfa hay and 41% raised native hay. Of the 45,000 tons harvested, 91% was for home use and 9% was done on a custom basis.

The average machinery investment for ranch operators was high—$6,200 for a swather, $13,000 for a Stakhand, $8,500 for a tractor and in addition there was some other miscellaneous equipment. These machines resulted in an average machinery investment of $28.24 per ton harvested.

The average cost of harvesting a ton of hay for the four small Stakhands was $6.80 and for the large machines the average cost was $7.08. Combining these two size groups resulted in an average cost of $7.05 per ton (Table 4). Fixed machinery cost was $4.52 per ton, labor cost was only 86 cents per ton and all other variable costs were $1.67 per ton. The average hay yield was 3.02 tons per acre and 2.50 tons were harvested per man hour (Table 4).

To study the influence of factors which affect the cost of harvesting hay with a Stakhand, data for the 34 farms were arrayed from high to low based on the cost per ton of hay harvested Table 4). The 25% comprising the low-cost group had a cost of $5.43, while the high-cost 25% had a cost of $9.27 per ton. The primary reason for the large difference in cost is explained in that

Table 4. Components of costs when stacking loose hay with Stakhands. (Comparing low-cost and high-cost operators—34 Wyoming farms, 1971).

	Ave. for 25% with:		Averages for 34 farms
	Lowest cost	Highest cost	
Average harvesting cost per ton			
Fixed cost	$ 3.25	$ 6.40	$ 4.52
Variable cost			
Labor	.79	.82	.86
All other	1.39	2.05	1.67
Total harvesting costs	$ 5.43	$ 9.27	$ 7.05
Organizational factors			
Machinery investment per ton	$16.66	$48.78	$28.24
Tons harvested per man hour	2.63	2.86	2.50
Average yield per acre (tons)	2.66	3.30	3.02
Tons harvested per farm	1,920	642	1,321

the low-cost group harvested 1,920 tons per farm and had a machinery investment of $16.66 per ton. In comparison the other group harvested only 642 tons per farm and had a machinery investment of $48.78—almost three times as much. This higher investment resulted in a fixed cost of $6.40 per ton which accounts for most of the difference in costs between the two groups.

The preceding comparison shows that cost per ton harvested is influenced by: a) the amount of tons harvested; b) the machinery investment per ton harvested; c) the tons harvested per man hour; and perhaps by d) the average yield per acre.

Harvesting Haylage

Haylage is defined as a hay crop which has wilted to about 40-60% moisture. This means there is about 40-60% total dry matter. About 1.8 tons of haylage with 50% dry matter are equal to one ton of hay with 90% dry matter (90/50=1.8).

Hay was cut with a swather and allowed to wilt down to about 50% moisture. The haylage is then run through a forage chopper and hauled by trucks to the silo. All the haylage in this study was stored in trench-type silos. A tractor was used to pack the haylage in the trench. Wheel-type tractors are the most popular as they do a more solid job of packing than do the crawler types. After the silo is filled it must be covered to prevent spoilage. A plastic sheet weighted with discarded automobile tires or with some of the wet haylage is frequently used as covering material. In a few cases when the haylage had more than 50% moisture, preservatives were added to prevent excess spoilage.

Thirty-seven farm schedules were taken to determine the components of the cost of harvesting haylage. Eleven were from Torrington-Lingle area, nine from the Riverton-Missouri Valley area, four in the Powell-Heart Mountain area, and three in the Wheatland area. The rest were scattered throughout the state. These 37 operators were harvesting about 58,000 tons (or 104,000 tons of haylage) for an average of 1,510 tons of alfalfa hay equivalent per farm with an average crew of five men.

Most farms are located on irrigated land. In addition to alfalfa hay they produced corn silage, beets, oats, and barley. Feeder lambs, feeder calves, or a small beef herd were also common.

The average cost of harvesting one ton of alfalfa hay equivalent in the form of 50% moisture haylage was $7.63 per ton (Table 5). The average yield was 4.76 tons per acre, the machinery investment cost per ton was $22.19 and there were .98 tons harvested per man hour (Table 5).

To study the factors which influence cost of harvesting haylage, the group with the lowest costs was compared with the 25% having the highest harvesting cost (Table 5). The low cost group had a cost of $6.52 per ton and harvested 2,462 tons of haylage yielding 4.37 tons per acre. They had a machinery investment of $16.11 and harvested 1.10 tons per man hour. In comparison, the group having the highest costs harvested only 922 tons per farm yielding 4.67 tons per acre at a harvest rate of .93 tons per man hour, with a machinery investment cost of $28.78 per ton. These factors resulted in a total cost per ton of $8.67. Machinery investment cost per ton and tons of haylage harvested per man hour seem to influence the total per ton cost of harvesting haylage.

Harvesting Alfalfa Hay with a Mobile Cuber

In 1971, 14 operators owned 21 mobile hay cubers and all were contacted by personal interview. Thirteen machines were located in the Riverton area, five in Park County, two in Big Horn County and one in Goshen County. These operators were cubing about 37,000 tons for an average of 1,760 tons per cuber with an average crew of three men. Nearly one-half or 16,500 tons were being cubed on a custom basis at an average charge of $10 per ton. The charge was $11.75 per ton if the man who did the cubing also contracted to haul and stack the cubes at the farmstead.

All operators raised alfalfa hay and barley while 86% raised corn for silage. Feeder cattle were the most popular livestock on these farms but they also had beef cattle, sheep, and dairy cows.

Machinery investment cost was $28.48 per ton. Much of this high machinery investment cost is accounted for by the cuber and cart which

Table 5. Components of cost when harvesting haylage.
(Comparing low-cost and high-cost operators—37 Wyoming farms, 1971).

	Ave. for 25% with:		Averages for 37 farms
	Lowest cost	Highest cost	
Average harvesting cost per ton			
Fixed cost	$ 3.00	$ 4.28	$ 3.61
Variable cost			
Labor	1.84	2.20	2.11
All other	1.68	2.19	1.91
Total harvesting costs	$ 6.52	$ 8.67	$ 7.63
Organizational factors			
Machinery investment per ton	$16.11	$28.78	$22.19
Tons harvested per man hour	1.10	.93	.98
Average yield per acre (tons)	4.37	4.67	4.76
Tons harvested per farm	2,462	922	1,510

have an "asking price" of about $40,000. The 21 cubers had an average harvest cost delivered and stacked at the farmstead, of $9.71 per ton, harvested at the rate of 1.52 tons per hour and had an average yield of 4.89 tons per acre (Table 6).

Data for the 21 cubers were arrayed based on cost per ton of cubing hay (Table 6). The low-cost group had a harvesting cost per ton of $8.45, a machinery investment cost per ton of $21.20, and a labor efficiency of 1.66 tons per man hour. The average yield was 5.60 tons per acre and over 2,300 tons were harvested per farm. In comparison the high-cost group had a machinery investment which was nearly double the other group, harvested considerable less tonnage per man hour, had lower yielding hay, and harvested about one-half as much hay per farm. As a result the harvest cost was $11.52 per ton with the largest part being the fixed machinery cost. This comparison shows that the investment cost per ton harvested as well as efficiency in the use of labor each have an important bearing on the total harvest cost per ton.

Table 6. Components of cost when harvesting hay with mobile cuber.
(Comparing low-cost and high-cost operators—21 Wyoming farms, 1971).

	Ave. for 25% with:		Averages for 21 farms
	Lowest cost	Highest cost	
Average harvesting cost per ton			
Fixed cost	$ 4.68	$ 6.93	$ 5.53
Variable cost			
Labor	1.44	1.73	1.55
All other	2.33	2.86	2.63
Total harvesting costs	$ 8.45	$11.52	$ 9.71
Organizational factors			
Machinery investment per ton	$21.20	$39.00	$28.48
Tons harvested per man hour	1.66	1.27	1.52
Average yield per acre (tons)	5.60	4.40	4.89
Tons harvested per farm	2,311	1,120	1,760