ALFALFA HARVESTING COSTS

A. D. Reed
Extension Economist
University of California, Davis

This publication shows the costs of various methods of harvesting field-cured hay. It covers conventional baling, large roll bales, loose hay stacking, field and stationary cubing. It is based on several field cubing and baling operations in the Sacramento and San Joaquin Valleys, and on three stationary cubing operations (six machines) all of which have operated several seasons. Figures for stacking wagons are based on cow-calf operations in California, plus large roll bale and stack data from the University of Oklahoma.

Cost Summary

Table 1 compares costs of harvesting alfalfa using the different harvesting methods. The costs in the table are based upon 5,000 tons annual production, an amount considered reasonable for most of the harvesting equipment. A stationary cuber can handle about 10,000 tons per year. These summary data show that cubing is the most expensive method. However, cubes have several advantages. These include mechanized handling and feeding, and reduced labor, storage space, and feeding waste. The overall cost of producing cubes in the field is less than for stationary operation when compared at the same annual tonnage. The difference is small when annual production exceeds the capacity of a single field machine. The large, round bales and stack wagons are the least expensive methods of harvest but these can be successfully transported for only a relatively short distance. Therefore their use is limited largely to ranches where the hay will be fed.

Hay harvesting involves large investments for equipment and facilities. Table 2 shows the approximate cost of equipment required for each system. These investment costs are reflected in the overhead cost of production in subsequent calculations.

Machine Performance and Cost Analysis

Field Cubing vs. Stationary Cubing--Several variables affect the productivity of the field cubing machine. Weather and its effect on hay moisture is one of the more important elements and cannot be controlled. Other factors such as irrigation timing and soil moisture, as well as general field conditions like ground roughness and crop uniformity, can be given limited control.

A stationary operation places the cuber out of the direct influence of field and weather and can operate for as long as hay is available. The stationary cuber can, therefore, be fed more uniformly at a rate near the machine's maximum output. Hay fed to the machine is also at a more uniform moisture level. These factors usually increased the hourly capacity of stationary cubers by at least 50 percent compared to field machines. While the capacities of both types of machines vary with conditions and management, it is not unreasonable to expect an average of 4 tons per hour with a field machine and 6 to 8 tons per hour with a stationary machine.

The number of hours of operation for a field cuber is limited to the period during the day when the hay is free of dew. In most areas this restricts operation to 8 to 12 hours each day. By contrast, stationary cubers can operate around the clock if a supply of hay is available. The stationary cuber output in this cost comparison was based on 16 hours a day (two 8-hour shifts) at an average output of 7 tons per hour. The number of days of operation per year may also be increased by either stockpiling chopped hay or using coarsely ground baled hay. Because of the extra costs, these two approaches have so far had only limited use. A normal seasonal operating period of 100 days was used for both the stationary and field machines.

The stationary cuber can be used to process artificially dried hay in areas where natural drying is unsatisfactory. A standby drier can be used for periods during the season to permit continuous operation of the cuber. Artificial drying, however, adds to the total cost of processing.

Although cubers are designed primarily for legume forages, they can be used for other materials, particularly agricultural crop residues like straw and cotton waste, and hay-grain mixtures. The stationary machine is best suited for these materials because adhesives must frequently be added and mixed before cubing.

While baling wire and tramp iron in hay cubes are not frequent problems, it is easier to provide magnets and metal removal equipment in a stationary cuber than in a field machine

The hay supply used in cubing operations is frequently drawn from a fairly large area. With field cubers, the entire operation including storage can be shifted to reduce the transport of hay. This is not possible with a stationary installation. Semiportable cubing units are available for in-field operation or for multiple site operation.

The multiple cuber aspect of a field cubing operation reduces the risk of a complete shutdown due to maintenance or repair problems. Mechanical failure on one field cuber would stop only a portion of the total. By contrast, mechanical failure in the single cuber of a stationary operation would completely stop cube production. However, stockpiling of chopped hay can continue despite stationary cuber breakdown, with around the clock operation when repairs are completed. Several stationary installations have two cubers, which also permits continued operation in the event of mechanical failure.

Stacks and Large Roll Bales--Large roll bales and stacks made with stacking wagons have gained widespread usage in much of the United States. They have had very limited use in California to date. It appears that they are suitable for use in cow-calf or dairy operations that produce and feed their own hay. They may also be suitable as a means of supplying hay to stationary and portable-stationary cubing or pelleting operations where the hay is grown within a short distance of the plant. In their present form, they do not appear to provide sufficient density and payload capabilities for long distance transport.

Cost figures show that the large roll bale and stack systems can reduce the cost of packaging and handling hay as long as the transport distance is relatively short. University of California Agricultural Sciences Leaflet 75-SP-3011 "Big Hay Bale," provides additional information.

Storage Requirements--The need for covered storage for cubes varies with local rainfall. Light rainfall damages the pile's surface somewhat, producing some quality loss and waste due to spoilage. Covered storage is recommended, but producers in areas of very limited rainfall may decide that the investment is not justified. For both the stationary and field cubing operations, the costs include a cube storage building to provide storage for 50 percent of the annual tonnage. Costs are based on a flat storage building providing 5 square feet of floor space per ton at $5.40 per square foot. A solid floor, usually concrete, is needed to minimize handling loss and to prevent mixing with dirt or gravel.

Stationary cubing also includes 30,000 square feet of asphalt slab for stockpiling chopped hay before cubing. This item is included under stationary cubing costs.

Large roll bales and stacks made with stacking wagons are generally not stored under cover. It is recommended that large roll bales and stacks not be placed in contact with each other in outside storage as moisture will move into the bales at the point of contact This precludes stacking large roll bales unless stored under cover.

Machine Costs--Machine life, output per hour and per season, and machine maintenance are major factors affecting the cost of hay harvest. Machine life is determined by wear-out or obsolescence, or both. In the case of a newly developed machine like the cuber, it is hard to estimate what these factors will be. Eight years seems to be a reasonable life. Life expectancy for the stationary cuber is estimated at 10 years because of less severe operating conditions. Life expectancy for other equipment is estimated from various references including the ASAE Yearbook.

"Other" charges shown in overhead costs are taxes, insurance, and storage of equipment computed at 2 percent of first cost of the machine of facility.

Repair costs are calculated for each operation. Data from field cubers indicate that expected annual repair costs are about 125 percent of the first cost for 10,000 hours or

wear-out life. Die wear is a major part of this total. Excessive maintenance during the operating season will be reflected in reduced annual production and higher overhead cost per ton. Many producers completely overhaul their cubing machines during the winter to reduce in-season maintenance. The figures are for normal operating conditions. Sandy soil or other factors creating unusual wear can increase repair costs.

Repair costs for stationary cubing were based on actual costs of existing installations with adjustments for inflation. Fuel consumption and repair information, unless otherwise noted, were taken from the ASAE Yearbook. Miscellaneous cash costs include office and telephone, interest on operating capital, and various small items.

A management and supervision charge of $1.10 per ton for cubes and $.55 for bales is included.

Cost Tables--The following pages are devoted to costs for harvesting alfalfa hay using the various methods which are available.

TABLE 1. Comparison of Hay Harvesting Costs--
5,000 Ton Per Year

	Conventional bale	Large round bale	Stack wagon	Field cube	Stationary cube
Swath	$ 1.35	$1.35	$1.35	$ 1.35	$ 1.35
Combine windrows	.40	.40			
Bale	4.95	.90			
Chop and haul					1.95
Cube				3.95	1.95
Stack			1.05		
Haul or roadside	.70	.45	.45	1.10	
Misc. overhead	.35	.25	.30	.70	1.35
Storage				1.50	1.50
Management	.55	.55	.55	1.10	2.75
Depreciation	2.60	1.65	1.90	3.00	6.70
Interest	.70	.50	.60	1.10	2.75
Total cost	$11.60	$6.05	$6.20	14.35	18.65

TABLE 2. Comparison of the Equipment Investment for the Various Methods of Harvesting Alfalfa at 5,000 Tons Harvested Per Year

	Conventional baler	Large round bale	Stack wagon	Field cube	Stationary cuber
Swather 14 ft S.P.	$21,000	$21,000	$21,000	$21,000	$21,000
Side rake (2)	5,250	5,250			5,250
Field cuber				65,000	
Stationary cuber					145,000
Water nurse truck				4,000	
Dump truck				10,000	
Stacker			30,000		
Baler - 3 wire pull	22,000				
Baler - large round bale		6,800			
Auto bale loader & stacker	20,500				
Forklift		9,500			
Dry hay chopper					7,200
Stack mover			11,000		
Chopped-hay wagon (3)					36,500
Cube storage				92,000	92,000
Tractors	19,500	19,500	12,000		19,500
Trucks					17,800
Total	$88,250	$62,050	$74,000	$192,000	$344,250

TABLE 3. Cost of Harvesting Alfalfa With a Regular Baler

Investment - up to 5,000 tons per year

	Number of machines	Price	Life (years)	Depreciation	Interest	Other	Total
Swather	1	$21,000	5	$ 4,200	$ 840	$ 420	$ 5,460
Side rakes	2	5,250	10	525	210	105	840
Baler, 3-wire pull type	1	22,000	6	3,667	880	440	4,987
Auto bale loader & stackers	1	20,500	8	2,563	820	410	3,793
Tractors	2	19,500	10	1,950	780	390	3,120
Total		$88,250		$12,905	$3,530	$1,765	$18,200

Operating cost

	Tons per hour	Per hour			Total	
		Labor	Fuel and Repairs	Materials	per hour	per ton
Swath	7	$4.50	$4.95		$ 9.45	$1.35
Combine windrows	20	4.50	3.00		7.50	.40
Bale	12	4.50	6.65	$48.00	59.15	4.95
Roadside bales	15	4.50	5.65		10.15	.70
Total						$7.40

Total Cost Per Ton at Various Annual Usage

Tons	Overhead cost per ton	Operating cost per ton	Management	Total cost per ton
1,000	$18.20	$7.40	$ .55	$26.15
2,000	9.10	7.40	.55	17.05
3,000	6.05	7.40	.55	14.00
4,000	4.55	7.40	.55	12.50
5,000*	3.65	7.40	.55	11.60
6,000	5.45	7.40	.55	13.40
7,000	4.65	7.40	.55	12.60
8,000	4.10	7.40	.55	12.05
9,000	3.60	7.40	.55	11.55
10,000	3.25	7.40	.55	11.20

*Approximate upper limit for one baler, swather, side rake, tractor

TABLE 4. Cost of Harvesting Alfalfa With a Large Round Bale Baler

Investment - up to 5,000 tons per year

	Number of machines	Price	Life (years)	Depreciation	Interest	Other	Total
Swather	1	$21,000	5	$ 4,200	$ 840	$ 420	$ 5,460
Side rakes	2	5,250	10	525	210	105	840
Forklift	1	9,500	10	950	380	190	1,520
Round baler	1	6,800	10	680	272	138	1,090
Tractor	1	19,500	10	1,950	780	390	3,120
Total		$62,050		$ 8,305	$2,482	$1,243	$12,030

Operating cost

	Tons per hour	Per hour			Total	
		Labor	Fuel and repairs	Materials	Per hour	Per ton
Swath	7	$4.50	$4.95		$9.45	$1.35
Combine windrows	20	4.50	3.00		7.50	.40
Bale	8	4.50	2.50		7.00	.90
Roadside bales	15	4.50	2.40		6.90	.45
Total						$3.10

Total Cost Per Ton At Various Annual Usage

Tons	Overhead cost per ton	Operating cost per ton	Management	Total cost per ton
1,000	$12.05	$3.10	$ .55	$15.70
2,000	6.00	3.10	.55	9.65
3,000	4.00	3.10	.55	7.65
4,000	3.00	3.10	.55	6.65
5,000*	2.40	3.10	.55	6.05
6,000	3.75	3.10	.55	7.40
7,000	3.20	3.10	.55	6.85
8,000	2.80	3.10	.55	6.45
9,000	2.50	3.10	.55	6.15
10,000	2.25	3.10	.55	5.90

*Approximate upper limit for one baler, swather, side rake, tractor

TABLE 5. Cost of Harvesting Alfalfa With a Wagon Stacker

Investment - up to 5,000 tons per year

	Number of machines	Price	Life (years)	Depreciation	Interest	Other	Total
Swather	1	$21,000	5	$4,200	$ 840	$ 420	$ 5,460
Stacker	1	30,000	10	3,000	1,200	600	4,800
Stack mover	1	11,000	10	1,100	440	220	1,760
Tractor	1	12,000	10	1,200	480	240	1,920
Total		$74,000		$9,500	$2,960	$1,480	$13,940

Operating costs

	Tons per hour	Per hour			Total	
		Labor	Fuel and repairs	Materials	Per hour	Per ton
Swath	7	$4.50	$4.95		$9.45	$1.35
Stack	9	4.50	4.75		9.25	1.05
Move	15	4.50	2.25		6.75	.45
Total						$2.85

Total Cost Per Ton At Various Annual Usage

Tons	Overhead cost per ton	Operating cost per ton	Management	Total cost per ton
1,000	$13.95	$2.85	$ .55	$17.35
2,000	6.95	2.85	.55	10.35
3,000	4.65	2.85	.55	8.05
4,000	3.50	2.85	.55	6.90
5,000*	2.80	2.85	.55	6.20
6,000	4.35	2.85	.55	7.75
7,000	3.75	2.85	.55	7.15
8,000	3.25	2.85	.55	6.65
9,000	2.90	2.85	.55	6.30
10,000	2.60	2.85	.55	6.00

*Approximate upper limit for one swather, stacker, tractor

TABLE 6. Cost of Harvesting Alfalfa With a Field Cuber

Investment - up to 5,000 tons per year

	Number of machines	Price	Life (years)	Depreciation	Interest	Other	Total
Swather	1	$21,000	5	$ 4,200	$ 840	$ 420	$ 5,460
Field cuber	1	65,000	8	7,315	260	1,300	8,875
Water nurse truck	1	4,000	10	360	160	80	600
Dump truck to haul	1	10,000	8	1,250	400	200	1,850
Storage for cubes	1	92,000		4,325	3,680	1,840	9,845
Total		$192,000		$17,450	$5,340	$3,840	$26,630

Operating cost

	Tons per hour	Per hour			Total	
		Labor	Fuel and repairs	Materials	Per hour	Per ton
Swath	7	$4.50	$ 4.95			
Cube	4	4.50	11.20			
Haul	4	4.50	1.25			
Storage						
Total						

Total Cost Per Ton At Various Annual Usage

Tons	Overhead cost per ton	Operating cost per ton	Management	Total cost per ton
1,000	$26.65	$7.90	$1.10	$35.65
2,000	13.30	7.90	1.10	22.30
3,000	8.90	7.90	1.10	17.90
4,000	6.70	7.90	1.10	15.70
5,000*	5.35	7.90	1.10	14.35
6,000	6.95	7.90	1.10	15.95
7,000	5.95	7.90	1.10	14.95
8,000	5.20	7.90	1.10	14.20
9,000	4.65	7.90	1.10	13.65
10,000	4.15	7.90	1.10	13.15

*Approximate upper limit for one swather, cuber, truck

TABLE 7. Cost of Harvesting Alfalfa With a Stationary Cuber

Investment - up to 5,000 tons per year

	Number of machines	Price	Life (years)	Depreciation	Interest	Other	Total
Swather	1	$21,000	5	$ 4,200	$ 840	$ 420	$ 5,460
Side rakes	2	5,250	10	525	210	105	840
Dry hay chopper	1	7,200	3	2,400	288	144	2,832
Tractor	2	19,500	10	1,650	660	330	2,640
Chopped hay wagon	3	36,500	10	3,650	1,460	730	5,840
Truck to pull wagons	1	17,800	3	5,934	712	356	7,002
Stationary cuber with auxiliary facilities 1/	1	145,000		10,866	5,800	2,900	19,566
Storage for cubes	1	92,000		4,325	3,680	1,840	9,845
Total		$344,250		$33,550	$13,650	$6,825	$54,025

Operating costs

	Tons per hour	Per hour			Total	
		Labor	Fuel and repairs	Materials	Per hour	Per ton
Swath	7	$4.50	$ 4.95		$ 9.45	$1.35
Chop and haul to cuber	10	4.50	15.00		19.50	1.95
Cube	4	4.50	3.20		7.70	1.95
Storage						1.50
Total						$6.75

Total Cost Per Ton At Various Annual Usage

Tons	Overhead cost per ton	Operating cost per ton	Management	Total cost per ton
1,000	$54.05	$6.75	$1.10	$61.90
2,000	27.00	6.75	1.10	34.85
3,000	18.00	6.75	1.10	25.85
4,000	13.50	6.75	1.10	21.35
5,000*	10.80	6.75	1.10	18.65
6,000	9.00	6.75	1.10	16.85
7,000	8.65	6.75	1.10	16.50
8,000	7.55	6.75	1.10	15.40
9,000	6.70	6.75	1.10	14.55
10,000	6.05	6.75	1.10	13.90

*Approximate upper limit for one swather, rake tractor combination

1/ See table 8

TABLE 8. Stationary Cubing (7 tons per hour - 1 cuber)

Investment and Annual Overhead Costs:

	Number of machines	Price	Life (years)	Depreciation	Interest	Other	Total
Paving for curing and storage, 30,000 sq ft of 6" concrete at $1.75	1	$ 52,500	20	$ 2,625	$2,100	$1,050	$ 5,775
Stationary cuber	1	22,000	10	2,200	880	440	3,520
Electric motor, 150 hp	1	4,300	20	215	172	86	473
Power controls (weather protected)	1	7,600	20	380	304	152	836
Scoop loader (4 ton)	1	12,000	10	1,200	480	240	1,920
Metering box, mixer, feed conveyor	1	24,000	10	2,400	960	480	3,840
Conveyor to truck	1	4,300	10	430	172	86	688
Magnets	1	1,150	20	58	46	23	127
Dump truck (2 ton)	1	10,000	10	1,000	400	200	1,600
Scales (30 ton)	1	7,150	20	358	286	143	787
Total		$145,000		$10,866	$5,800	$2,900	$19,566

TABLE 9. Cost to Store Cubes

Investment and Annual Overhead Costs for 5,000 Tons:

	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Storage shed	1	$67,500	30	$2,250	$2,700	$1,350	$6,300
Scoop loader	1	12,000	10	1,200	480	240	1,920
Elevator, loading and stacking	1	5,000	10	500	200	100	800
Scales, 30 ton	1	7,500	20	375	300	150	825
Total		$92,000		$4,325	$3,680	$1,840	$9,845

Cash Operating Costs:	Per ton
Labor	$ .45
Fuel	.30
Miscellaneous, electrical power, repairs to shed & equipment	.75
Total	$1.50