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Revision of AXT-346

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ALFALFA HARVESTING COSTS

This publication shows the costs of various methods of harvesting field-cured hay. It covers conventional baling, field and stationary cubing, and--to a limited extent--loose hay stacking and baling with large roll bales, and updates the 1971 publication Alfalfa Harvesting Costs, AXT-346. 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 one cow-calf operation in California, plus large roll bale and stack data from the University of Oklahoma.

Cost Summary

Table 1 compares costs of producing alfalfa bales and alfalfa cubes with field and stationary equipment. The costs in the table are based upon 10,000 tons annual production, an amount considered reasonable for one stationary cuber and maximum for two field cubers or two balers. These summary data show that cubing is more expensive than baling. However, cubes have several advantages over bales. 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.

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

TABLE 1. Comparison of Baling, Field Cubing, and Stationary Cubing Costs - 10,000 Ton Production Per Year.

	Cost per ton		
	Bale	Field cube	Stationary cube
Swath	$2.37	$ 2.37	$ 2.37
Combine windrows	.57	--	.57
Field cube	--	5.46	--
Water nurse truck	--	.40	--
Haul cubes to storage	--	2.01	--
Bale	4.71	--	--
Roadside bales	1.04	--	--
Chop dry hay and haul to stationary cuber	--	--	4.05
Stationary cube	--	--	4.95
Weigh	.08	--	--
Store	.15	2.23	2.23
Management	.35	.75	.75
Total	$9.27	$13.22	$14.92

TABLE 2. Comparison of Equipment Investment for Baling, Field Cubing, and Stationary Cubing for 10,000 Tons Per Year.

	Number required	Bale	Field cube	Stationary cube
Swather 14 ft. S.P.	2	$29,100	$ 29,100	$ 29,100
Side rakes (2) & tractor comb.	2	14,400	--	14,400
Field cuber[1]	2	--	110,000	--
Water nurse truck	1	--	3,000	--
Dump truck to haul cubes	2	--	14,700	--
Baler, 3-wire pull type[1]	2	19,800	--	--
Tractor to pull baler	2	10,500	--	--
Auto bale loader & stacker	1	17,700	--	--
Dry hay chopper	2	--	--	10,600
Tractor to pull chopper	2	--	--	27,000
Chopped-hay wagon	6	--	--	54,000
Truck to pull wagons	2	--	--	12,800
Stationary cuber with auxiliary facilities[2]	1	--	--	107,350
Storage for cubes	1	--	117,900	117,900
Total		$91,500	$274,700	$373,150

[1]Maximum annual output estimated at 5,000 tons per machine.

[2]Maximum annual output estimated at 12,000+ tons.

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.

This 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.

Production of Complete Ration Cubes - Much attention is being given to the potential of complete ration cubes where feed supplements are added to the forage. Animal nutritionists are interested in complete ration cubes for

dairy cows to save labor and feeding time, and to improve efficiency. Feed supplements can be easily added in a stationary plant but not in a field machine.

Labor Requirements - A comparison of all systems at 10,000 tons per year shows approximate labor requirement at 0.79 man-hours per ton for field cubing, 0.82 for stationary cubing, and 0.33 for baling. This compares with .42 man-hours for large roll bales and .34 man-hours for loose hay stacking wagons, allowing a 5 mile haul to storage for each.

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. Leaflet 75-SP-3011 "Big Hay Bale," provides current cost and performance data.

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 $4.00 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 and success of the cubing operation. 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. Many field cubers have now completed 8 years of service, and a few have operated for 9 years. Therefore, 8 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.

Except for storage shed and elevators, depreciation and interest charges allows for 10 percent salvage value. "Other" charges shown in overhead costs are taxes, insurance, and storage of equipment computed at 2 percent of first cost of the machine or facility. Footnotes on Table 7 show how these calculations are made.

For some machines, only part of the overhead cost has been assigned to the operation because the machine can be used for other work when not in use on this operation. Machines in this group are the water nurse truck, the motor scoop, the tractor for combining windrows, and the scales; 50 percent of these were charged to the operation. The tractor used to pull the baler was charged at 75 percent.

The method of calculating repairs is shown 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 obtained by averaging actual costs of existing installations. 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 $0.75 per ton for cubes and $0.35 for bales is included in the summary of Table 1.

Cost Tables - The following pages are devoted to overhead and cash costs for baling, field cubing, stationary cubing, and costs of supplementary operations like swathing, combining windrows, hauling cubes and bales to storage, and chopping and hauling dry hay for stationary cubing and storage.

TABLE 3. Cost of Swathing

	Investment and Annual Overhead Costs						
	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Swather 14 ft. S.P.	1	$14,550	4	$3,274	$640	$290	$4,204

Cash Operating Costs

	Per hour	Tons per hour	Per hour
Labor - 1 Man	$3.50	7	$0.50
Fuel	.80	7	.11
Repairs[1]	5.82	7	.83
Miscellaneous	--	--	.09
Total			1.53

Total Cost Per Ton at Varying Outputs

Tons	Cost Per Ton		
	Overhead	Cash	Total
1,000	$4.20	$1.53	$5.73
2,000	2.10	1.53	3.63
3,000	1.40	1.53	2.93
4,000	1.05	1.53	2.58
*5,000	.84	1.53	2.37
6,000	1.40	1.53	2.93
7,000	1.20	1.53	2.73
8,000	1.05	1.53	2.58
9,000	.93	1.53	2.46
10,000	.84	1.53	2.37

[1]Price x 100% of 2500 hrs. or wear-out life.

*Approximate upper limit for one machine.

TABLE 4. Costs to Combine Two Windrows for Baling and Chopping

Investment and Annual Overhead Costs

	Number of Machines	Price	Life (years)	Depreciation	Interest	Other	Total
Side rake	2	$4,200	10	$378	$185	$ 84	$ 647
Tractor	1	3,000[1]	10	270	132	60	462
Total		$7,200	--	$648	$317	$144	$1,109

Cash Operating Costs

	Per hour	Tons per hour	Per ton
Labor - 1 man	$3.50	20	$.18
Fuel	.64	20	.03
Repairs (rakes & tractor)[2]	2.28	20	.11
Miscellaneous	--	--	.03
Total			$.35

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$1.11	$.35	$1.46
2,000	.55	.35	.90
3,000	.37	.35	.72
4,000	.28	.35	.63
*5,000	.22	.35	.57
6,000	.37	.35	.72
7,000	.32	.35	.67
8,000	.28	.35	.63
9,000	.25	.35	.60
10,000	.22	.35	.57

[1] One-half share.

[2] Rakes price x 100% of 2500 hrs. or wear-out life.
Tractor price x 120% of 12,000 hrs. or wear-out life.

* Approximate upper limit for one tractor-rake unit.

TABLE 5. Cost of Baling

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Baler (3-wire)	1	$ 9,900	6	$1,485	$436	$198	$2,119
Tractor	1	5,250[1]	10	473	231	105	809
Total		$15,150	--	$1,958	$667	$303	$2,928

Cash Operating Costs

	Per hour	Tons per hour	Per ton
Labor - 1 man	$3.50	12	$0.29
Fuel	2.00	12	.17
Repairs[2]	4.26	12	.36
Baling wire	--	--	3.00
Miscellaneous	--	--	.30
Total			$4.12

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$2.93	$4.12	$7.05
2,000	1.46	4.12	5.58
3,000	.98	4.12	5.10
4,000	.73	4.12	4.85
*5,000	.59	4.12	4.71
6,000	.98	4.12	5.10
7,000	.84	4.12	4.96
8,000	.73	4.12	4.85
9,000	.65	4.12	4.77
10,000	.59	4.12	4.71

[1]Three-fourths share.

[2]Baler price x 90% of 2,500 hrs. or wear-out life.
Tractor price x 120% of 12,000 hrs. or wear-out life.

*Approximate upper limit for one baler.

TABLE 6. Cost of Roadsiding Bales

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Automatic loader stacker	1	$17,700	8	$1,991	$779	$354	$3,124

Cash Operating Costs

	Per hour	Tons per hour	Per ton
Labor	$3.50	15	$0.23
Fuel	1.60	15	.11
Repairs[1]	5.31	15	.35
Miscellaneous	--	--	.04
Total			.73

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$3.12	$0.73	$3.85
2,000	1.56	.73	2.29
3,000	1.04	.73	1.77
4,000	.78	.73	1.51
5,000	.62	.73	1.35
6,000	.52	.73	1.25
7,000	.45	.73	1.18
8,000	.39	.73	1.12
9,000	.35	.73	1.08
10,000	.31	.73	1.04

[1]Price x 75% of 2,500 hrs. or wear-out life.

TABLE 7. Cost of Field Cubing

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depreciation[1]	Interest[2]	Other[3]	Total
Field cuber	1	$55,000	8	$6,188	$2,420	$1,100	$9,708

Cash Operating Costs

	Per hour	Tons per hour	Per ton
Labor - 1 man	$4.00	4	$1.00
Fuel	2.40	4	.60
Repairs[4]	6.88	4	1.72
Miscellaneous	--	--	.20
Total			$3.52

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$9.71	$3.52	$13.23
2,000	4.85	3.52	8.37
3,000	3.24	3.52	6.76
4,000	2.43	3.52	5.95
*5,000	1.94	3.52	5.46
6,000	3.24	3.52	6.76
7,000	2.77	3.52	5.99
8,000	2.43	3.52	5.95
9,000	2.16	3.52	5.68
10,000	1.94	3.52	5.46

[1]Price less 10% salvage ÷ 8 years.

[2]Price plus 10% salvage ÷ 2 = average value X 8%.

[3]Price X 2% to cover taxes, insurance, and housing.

[4]Price X 125% of 10,000 hrs. or wear-out life.

*Approximate upper limit for one cuber.

TABLE 8. Water Nurse Truck

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Truck	1.0	$3,000[1]	10	$270	$132	$60	$462

Cash Operating Costs

	Per ton
Labor	$0.22
Fuel and repairs	.12
Miscellaneous	.02
Total	$0.36

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$0.46	$0.36	$0.82
2,000	.23	.36	.59
3,000	.15	.36	.51
4,000	.12	.36	.48
5,000	.09	.36	.45
6,000	.08	.36	.44
7,000	.07	.36	.43
8,000	.06	.36	.42
9,000	.05	.36	.41
10,000	.04	.36	.40

[1]One-half share.

TABLE 9. Cost to Haul Cubes to Storage

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Dump truck (5-ton)	1	$7,350[1]	8	$827	$323	$147	$1,297

Cash Operating Costs

	Per hour	Tons per hour	Per ton
Labor - 1 man	$3.50	4	$0.88
Fuel	--	--	.44
Repairs	--	--	.33
Miscellaneous	--	--	.10
Total			$1.75

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$1.30	$1.75	$3.05
2,000	.65	1.75	2.40
3,000	.43	1.75	2.18
4,000	.32	1.75	2.07
*5,000	.26	1.75	2.01
6,000	.43	1.75	2.18
7,000	.37	1.75	2.12
8,000	.32	1.75	2.07
9,000	.29	1.75	2.04
10,000	.26	1.75	2.01

[1]Three-fourth share.

*Approximate upper limit for one truck.

TABLE 10. Chop Dry Hay From Windrow and Haul to Stationary Cuber

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Pull-type chopper	1	$ 5,300	3	$1,590	$ 233	$ 106	$ 1,929
Tractor W.D. 95 dbhp	1	13,500[1]	10	1,215	594	270	2,079
Wagon, 7-ton cap.	3	27,000	10	2,430	1,188	540	4,158
Truck, to pull wagons	1	6,400	3	1,920	282	128	2,330
Total		$52,200	--	$7,155	$2,297	$1,044	$10,496

Cash Operating Costs

	Per hour	Tons per hour	Per ton
Labor - 2 men at $3.50	$7.00	10	$0.70
Repairs - chopper, tractor, wagons, truck	6.79	10	.68
Fuel - Tractor, 95 dbhp X 75% = 71 X .065 gal/hr/hp = 4.63 X .32	1.48	10	.15
Truck	2.84	10	.28
Miscellaneous	--	--	.14
Total			$1.95

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$10.50	$1.95	$12.45
2,000	5.25	1.95	7.20
3,000	3.50	1.95	5.45
4,000	2.62	1.95	4.57
5,000	2.10	1.95	4.05
*6,000	3.50	1.95	5.45
7,000	3.00	1.95	4.95
8,000	2.62	1.95	4.57
9,000	2.33	1.95	4.28
10,000	2.10	1.95	4.05

[1]Three-fourth share.

*Approximate upper limit for one harvesting unit.

TABLE 11. Stationary Cubing (7 tons per hour - 1 cuber)

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depre-ciation	Interest	Other	Total
Paving for curing and storage, 30,000 sq. ft. of 6 in. concrete at $1.25	1	$ 37,500	20	$1,875	$1,500	$ 375	$ 3,750
Stationary cuber	1	17,000	10	1,530	748	340	2,618
Electric motor, 150-hp	1	3,200	20	144	141	64	349
Power controls (weather protected)	1	5,600	20	252	246	112	610
Scoop loader (4-ton)	1	9,000[1]	10	810	396	180	1,386
Metering box, mixer, feed conveyor	1	18,000	10	1,620	792	360	2,772
Conveyor to truck	1	3,200	10	288	141	64	493
Magnets	1	850	20	39	37	17	93
Dump truck (2-ton)	1	7,500	10	675	330	150	1,155
Scales (30-ton)	1	5,500[1]	20	248	242	110	600
Total		$107,350	--	$ 7,481	$4,573	$1,772	$13,826

Cash Operating Costs

	Per ton
Labor	$1.20
Repairs	1.50
Power 200 hp X 1 kwh/hp/hr X 2 1/4¢ = $4.50 ÷ 7 tons	.64
Miscellaneous	.23
Total	$3.57

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$13.83	$3.57	$17.40
2,000	6.91	3.57	10.48
3,000	4.61	3.57	8.18
4,000	3.46	3.57	7.03
5,000	2.77	3.57	6.34
6,000	2.30	3.57	5.87
7,000	1.99	3.57	5.56
8,000	1.73	3.57	5.30
9,000	1.54	3.57	5.11
10,000	1.38	3.57	4.95

[1]One-half share.

TABLE 12. Cost to Store Cubes

Investment and Annual Overhead Costs

	Number of machines	Price	Life (years)	Depreciation	Interest	Other	Total
Storage shed[1]	1	$50,000	30	$1,667	$2,000	$1,000	$4,667
Scoop loader	1	9,000[2]	10	810	396	180	1,386
Elevator, loading and stacking	1	3,400	10	306	150	68	524
Scales, 30-ton	1	5,500[2]	20	248	242	110	600
Total		$67,900	--	$3,031	$2,788	$1,358	$7,177

Cash Operating Costs

	Per ton
Labor	$0.32
Fuel	.20
Miscellaneous, electric power, repairs to shed & equipment	.53
Total	$1.05

Total Cost Per Ton at Varying Outputs

Tons	Cost per ton		
	Overhead	Cash	Total
1,000	$7.18	$1.05	$8.23
2,000	3.59	1.05	4.64
3,000	2.39	1.05	3.44
4,000	1.79	1.05	2.84
5,000	1.44	1.05	2.49
6,000	1.97	1.05	3.02
7,000	1.69	1.05	2.74
8,000	1.48	1.05	2.53
9,000	1.32	1.05	2.37
10,000	1.18	1.05	2.23

[1]Cube storage overhead added in 2,500-ton increments up to 50% of the total seasonal output of the system in use.

[2]One-half share.

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