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Acquiring Alfalfa Hay Harvest Equipment: A Financial Analysis of Alternatives

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INTRODUCTION AND SUMMARY

Harvesting equipment must be acquired by every crop producer, but there are alternative methods of acquisition. The question of whether an alfalfa hay producer is better off owning harvesting equipment or custom hiring someone else to perform harvesting services is addressed in this study. A financial analysis is presented for three alternate courses of action: (1) buy all new harvest equipment, (2) buy all used harvest equipment, and (3) custom hire the harvest job. The purchase-versus-lease decision has been approached in various ways in the past. Some studies have emphasized factors affecting the decision, such as taxes (Franks and Hodges), asset lives (VanTassell and Nixon, Weingartner), and financial risk (Levy and Sarnat). Alternate methods of analysis have been used, such as internal rate of return (Van Horne pp. 523-525) and present value analysis of after-tax cash flows (Lee et al., Boehlje and Eidman, Hinman and Willet). The analysis presented in this study is based upon a present value after-tax framework as the method most often recommended.

The objectives of this report are (1) to present the results of a study for alfalfa hay and (2) to illustrate how financial analyses may be structured as a guide for undertaking purchase/lease decisions. This case study has broad applicability because the methods used are relevant to any equipment acquisition decision.

The analysis is based on data collected during November-December 1991 through interviews with equipment manufacturers, custom harvest operators, and growers located in four major production regions of California: the high desert (the Lancaster-Barstow area), the low desert (Imperial Valley), the San Joaquin Valley and the Sacramento Valley. Respondents were selected using cluster and stratified random sampling techniques to minimize the sample size required (Blank). Using the data collected, the expected cost of owning and operating the necessary harvest equipment was estimated over the average period such equipment is usually held. The estimated cost for both new and used equipment was then compared against current custom rates to reach a preliminary conclusion. In the second part of the analysis, risk factors which might alter the preliminary conclusion for individual growers were evaluated. In general, the results show that small scale growers are better off custom harvesting, while purchasing used or new equipment becomes more attractive to growers as their scale of operation increases. However, risk factors can significantly effect the final decision regarding equipment acquisition.

Alfalfa is a prominent crop in California. For the past 30 to 40 years, planted acreage has been about 1.1 million acres (approximately 10 percent of the irrigated acres in the state), fluctuating up or down about 100,000 to 150,000 acres. Alfalfa is produced in nearly every county in the state, from the low desert in the south, to the mountain counties in the north.

Harvesting is a crucial aspect of the alfalfa production system. Unlike most crops which are only harvested once per season, alfalfa is harvested an average of seven times per season depending primarily on climatic conditions. For example, nine to ten cuttings are common in the low desert of Southern California, while three to four cuttings are the norm in the Intermountain region of Northern California. Alfalfa may be harvested for silage, cubes, or bales. Three-twine hay bales (ranging in weight from 100 to 150 pounds depending on the market) are by far the most common end-product in California, so only this harvesting system will be addressed in this paper.

Alfalfa harvesting is typically a four step process, consisting of cutting, raking, baling, and roadsiding. Alfalfa is cut with a swather on a 26 to 45 day schedule. The cutting schedule varies depending on the time of year, geographic area, weather conditions, and the intended market (e.g. dairy vs horse market). The next phase of the harvesting process involves drying the alfalfa from a moisture content of approximately 80 percent when cut, down to a moisture content suitable for baling (approximately 16 percent or less). This phase, commonly referred to as the curing phase, typically requires four to seven days and is primarily a function of environmental conditions. In most areas the hay is usually raked once prior to baling to accelerate the drying process. Usually one to three days after raking, the hay has dried sufficiently and is baled when there is sufficient moisture or dew to "re-wet" the leaves and prevent leaf loss. After baling, the hay is roadsided, which simply means removing the bales from the field with a bale wagon and stacking the bales off the field either outside or in a covered barn.

Proper harvesting is essential, as poor harvesting practices or poor timing can significantly reduce both yield and quality. If cutting is delayed and the alfalfa is not cut at the proper stage of maturity, fiber levels increase while protein and total digestible nutrient levels decrease, lowering the value of the hay for dairy markets. A delay in cutting can also postpone irrigation which can have a significant negative effect on yields. Timing of raking and baling can be critical. Both raking and baling operations must be performed when there is adequate moisture or leaf loss can be excessive and both yield and quality suffer. The time period when there is sufficient moisture for baling (baling window) varies depending on the area and environmental conditions. In the high desert, for example, the baling window is typically three hours (slightly before sunrise to early morning) and can be eight hours or longer in the Central Valley (10-12:00 p.m. to approximately 6 or 7 in the morning or even later). Timing of roadsiding is not as critical, but should be done the same day as baling to allow prompt irrigation and to minimize damage to alfalfa regrowth buds from balewagon traffic.

EQUIPMENT NEEDED

The analysis in this report focuses on four pieces of equipment required to harvest hay. This "team" of equipment includes a self-propelled swather, a rake, a baler, and a balewagon. In addition, a tractor must be available to pull the rake and baler (our survey found no one using a self-propelled baler). Table 1 presents expected cost and performance information concerning this equipment when purchased new or used. The same equipment can be used with other forage crops, such as cereal forages, Sudan grass, and Bermuda, but only its use in harvesting alfalfa hay is considered in this study.

To facilitate the analysis, this report considers only the two cases of a team of new equipment and a team of used equipment (at the time of purchase). Although many hay growers and custom harvesters own teams of equipment made up of both new and used machines, no "mixed team" is assessed here. Instead, tables of financial results are presented separately for each piece of new and used equipment, thus enabling interested readers to estimate the results for any combination of equipment.

Another simplification of the analysis is to consider only the cases of growers or custom harvesters who perform all four tasks (swathing, raking, baling, and roadsiding). The results of the survey indicate that many growers have one or more of the harvest operations done custom while performing the others themselves. In particular, roadsiding is often done on a custom basis because balewagons are expensive and the timing of roadsiding is not critical (roadsiding does not require special moisture conditions). Custom rates quoted in the interviews for various combinations of the harvesting tasks are reported later for readers wishing to estimate the cost of a split decision (purchase some equipment and custom hire the remainder). But first, we focus on quantifying the purchase decision.

Table 1. Alfalfa Hay Harvest Equipment Costs

Equipment	Purchase Price	Life, Hours*	Repairs† (annual)	Fuel Use (gal/hr)	Harvesting Capacity
New:					
Swather	$45,000-60,000	4,000-8,000	$1,000-3,000	3.0	6 acres/hr
Rake (wheel)	14,000-18,000	4,500-9,000	1,000-1,500	----	15 acres/hr
Baler, pull type	32,000-40,000	3,000-6,000	2,000-3,000	2.5	12 tons/hr
Balewagon	60,000-88,000	4,000-8,000	1,000-1,500	5.0	18 tons/hr
Used:					
Swather	$18,000-24,000	4,000	$3,000-4,000	3.0	6 acres/hr
Rake (wheel)	3,000-8,000	4,500	----	----	15 acres/hr
Baler, pull type	10,000-19,000	3,000	4,000-5,000	2.5	12 tons/hr
Balewagon	25,000-40,000	4,000	3,000-4,000	5.0	18 tons/hr
Tractor, 40 hp	$15,000-25,000	10,000	$1.55/hr	3.2	----

* Length of time held until trade-in or salvage.

† Repairs are based on interview responses.

ANNUAL OWNERSHIP AND OPERATING COSTS

The first step in this analysis is to determine the expected total cost of owning and operating harvest equipment.[1] Since there is an active market for used equipment in California, each purchase alternative (buying new versus used) is evaluated separately. In each case, it is assumed that the equipment will be financed. Table 2 presents the details of typical loans for the equipment described in Table 1. At present, five-year loans at 11% interest are the most common in California and, therefore, are included in the analyses below.

An analysis of the expected cost of owning harvest equipment must include cash flows over a number of years while the expenditure for custom hiring is a single year cost. Thus, it is not correct to take the simple average cost of ownership over the useful life of the useful life of the equipment and compare it to the custom cost. Most importantly, by investing in harvest equipment the grower is tying up money that could be generating earnings in another investment. This income foregone is the opportunity cost of the investment. In addition, uncertainty and inflation make a future dollar less valuable than today's dollar. Nominal interest rates reflect the opportunity cost of not immediately putting money into the best alternative use, overall inflation and investment risk.

To account for the level and timing of the grower's expenses, present value analysis is used to compare the cost of owning harvest equipment to custom hiring. In this type of analysis all cash flows are adjusted into their current

Table 2. Principal and Interest Payments on Loans for Hay Harvesting Equipment

Equipment	Purchase Price	Down Payment	Principal	Term (years)	Total Interest Paid
New:*					
Swather	$52,500	$18,000	$34,500	5	$12,665
Rake (wheel)	16,000	4,000	12,000	5	4,405
Baler, pull type	36,000	10,000	26,000	5	9,545
Balewagon	74,000	25,000	49,000	5	17,988
Used:					
Swather	$21,000	$5,250	$15,750	5	$5,782
Rake (wheel)	5,500	1,375	4,125	5	1,514
Baler, pull type	14,500	3,625	10,875	5	3,992
Balewagon	32,500	8,125	24,375	5	8,948
Tractor, 40 hp	$20,000	$5,000	$15,000	5	$5,293

*Trade-in value of equipment is used as down payment.

[1]"Expected" costs are reported in this study because the data are from a survey. An individual can substitute some of their actual data in this analysis, but other values must be forecast, such as future repair costs, thus all results reflect expected values which are subject to error.

purchasing power equivalents and added together to calculate the net present value. The equivalent annual annuity is then calculated from the net present value. It represents the annual expenditure of equal amounts[2] that is equivalent to the uneven cash outlays for the harvest equipment purchase and use. Equipment with unequal lives and/or annual cash expenses can be evaluated against one another and a single year's custom harvesting contract by comparing the corresponding equivalent annual annuities and the custom rate. It should be pointed out that both the operating costs and custom rates may increase with inflation. However, for the purposes of this analysis the operating costs are adjusted for inflation and the custom rates are not because custom rates for only the most recent year are used. The results should be interpreted as guidelines for a decision made in the present and not for decisions made in the future. Also, it is noted that custom rates have not increased at the rate of inflation over the last seven years.

In this study, it is assumed that all growers cut their hay seven times each year and have an average annual yield of 8.4 tons per acre (1.2 tons per acre per cutting). These values are representative for the four producing regions included in the study (Klonsky and Livingston).

New Equipment

Total and annual expected costs of owning and operating harvest equipment vary depending on three factors: acreage harvested, interest rate, and tax rate. Therefore, cost estimates are made for several combinations of these factors. A summary of these results is presented later (in Table 12), but first an explanation of how the estimates are calculated is outlined.

Tables 3 through 7 present the details for each piece of equipment based on the combination of factors considered to be most representative of the current situation in California. The case presented in the tables exemplifies a grower intending to keep the harvest equipment for ten years while harvesting 500 acres annually, paying 11% interest and having a marginal tax rate of 28%. Such a grower is expected to face after-tax total annual costs averaging $45,165 for the five pieces of equipment (expressed in current dollars as the equivalent annual annuity listed at the bottom of each table). The variables appearing in Tables 3 through 7 are described briefly below.

A. Downpayment

This amount comes from Table 2 and represents the total trade-in value expected for the piece of equipment after it has been used 3000 to 5000 hours. Typically, this is the age at which equipment is traded-in and it is common for trade-ins to be used in lieu of cash downpayments.

B. Loan Amounts

The total annual interest and principal payment amounts come from standard loan amortization calculations.

C. Property Taxes and Insurance

These estimated values are based on the current value of the equipment. County assessors typically use a given percent of the purchase price (such as 1% for taxes) for Year 1 and then gradually reduce that percentage to half its original amount by Year 10.

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[2] An "annuity" is defined as a series of payments of an equal amount of money at fixed intervals for a specified number of periods (Van Horne). Annuities can have payment intervals which are annual, monthly, etc. The equivalent annual annuity method is a standard procedure used to enable comparisons of projects with unequal lives.

Table 3. Annual Ownership & Operating Costs: New 14' Swather

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	18,000	—	—	—	—	—	—	—	—	—
Unpaid Balance	34,500	28,960	22,811	15,986	8,410	—	—	—	—	—
Annual loan pmt.	9,335	9,335	9,335	9,335	9,335	—	—	—	—	—
Interest payment	3,795	3,186	2,509	1,758	925	—	—	—	—	—
Principal payment	5,540	6,149	6,825	7,576	8,410	—	—	—	—	—
Property taxes	525	436	399	378	362	336	315	305	289	263
Insurance	289	242	221	210	200	184	173	168	158	147
Total ownership costs	28,148	10,012	9,954	9,923	9,896	520	488	473	446	410
Operating costs:										
Fuel	1,399	1,406	1,413	1,420	1,427	1,435	1,442	1,449	1,456	1,463
Labor	5,078	5,103	5,129	5,154	5,180	5,206	5,232	5,258	5,285	5,311
Repairs	1,519	2,303	2,937	3,490	3,990	4,452	4,883	5,290	5,678	6,048
Total operating costs	7,996	8,812	9,479	10,065	10,598	11,092	11,557	11,997	12,418	12,823
Total costs:	36,145	18,824	19,433	19,988	20,494	11,612	12,045	12,470	12,865	13,232
Deductible expenses:										
Depreciation	5,623	10,043	7,891	6,431	6,431	6,431	6,431	3,218	—	—
Interest	3,795	3,186	2,509	1,758	925	—	—	—	—	—
Property taxes	525	436	399	378	362	336	315	305	289	263
Insurance	289	242	221	210	200	184	173	168	158	147
Operating costs	7,996	8,812	9,479	10,065	10,598	11,092	11,557	11,997	12,418	12,823
Total deductions	18,228	22,718	20,498	18,843	18,516	18,043	18,476	15,688	12,865	13,232
Tax savings	5,104	6,361	5,740	5,276	5,184	5,052	5,173	4,393	3,602	3,705
Salvage value	—	—	—	—	—	—	—	—	—	18,000
Depreciated value	—	—	—	—	—	—	—	—	—	0
Capital gain/loss	—	—	—	—	—	—	—	—	—	18,000
Tax on gain/write-off	—	—	—	—	—	—	—	—	—	5,040
Total after-tax costs:	31,041	12,463	13,694	14,712	15,310	6,560	6,872	8,077	9,263	-3,433
Net present value	79,603									
Equiv. annual annuity	13,517									

Assumptions:
To swath 500 acres 7 times a year requires 583 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.

Fuel Use: 3 gallons/hour
Fuel Price: .80 dollars/gallon
Labor Rate: 6.50 dollars/hour

Table 4. Annual Ownership & Operating Costs: New Wheel Rake

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	4,000	----	----	----	----	----	----	----	----	----
Unpaid Balance	12,000	10,073	7,934	5,560	2,925	----	----	----	----	----
Annual loan pmt.	3,247	3,247	3,247	3,247	3,247	----	----	----	----	----
Interest payment	1,320	1,108	873	612	322	----	----	----	----	----
Principal payment	1,927	2,139	2,374	2,635	2,925	----	----	----	----	----
Property taxes	160	133	122	115	110	102	96	93	88	80
Insurance	88	74	67	64	61	56	53	51	48	45
Total ownership costs	7,495	3,453	3,436	3,426	3,418	158	149	144	136	125
Operating costs:										
Fuel	0	0	0	0	0	0	0	0	0	0
Labor	2,029	2,040	2,050	2,060	2,070	2,081	2,091	2,102	2.112	2,123
Repairs	232	328	401	463	518	568	613	655	695	733
Total operating costs	2,261	2,367	2,451	2,523	2,588	2,648	2,704	2,757	2,807	2,855
Total costs:	9,756	5,820	5,887	5,949	6,006	2,807	2,853	2,901	2,943	2,980
Deductible expenses:										
Depreciation	1,714	3,061	2,405	1,960	1,960	1,960	1,960	981	----	----
Interest	1,320	1,108	873	612	322	----	----	----	----	----
Property taxes	160	133	122	115	110	102	96	93	88	80
Insurance	88	74	67	64	61	56	53	51	48	45
Operating costs	2,261	2,367	2,451	2,523	2,588	2,648	2,704	2,757	2,807	2,855
Total deductions	5,543	6,742	5,917	5,274	5,041	4,767	4,813	3,882	2,943	2,980
Tax savings	1,552	1,888	1,657	1,477	1,412	1,335	1,348	1,087	824	834
Salvage value	----	----	----	----	----	----	----	----	----	4,000
Depreciated value	----	----	----	----	----	----	----	----	----	0
Capital gain/loss	----	----	----	----	----	----	----	----	----	4,000
Tax on gain/write-off	----	----	----	----	----	----	----	----	----	1,120
Total after-tax costs:	8,204	3,933	4,230	4,473	4,595	1,472	1,505	1,814	2,119	-734
Net present value	22,218									
Equiv. annual annuity	3,773									

Assumptions:
To rake 500 acres 7 times a year requires 233 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.

Fuel Use: 3 gallons/hour
Fuel Price: .80 dollars/gallon
Labor Rate: 6.50 dollars/hour

Table 5. Annual Ownership & Operating Costs: New Baler, Pull-Type

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	10,000	—	—	—	—	—	—	—	—	—
Unpaid Balance	26,000	21,825	17,191	12,047	6,338	—	—	—	—	—
Annual loan pmt.	7,035	7,035	7,035	7,035	7,035	—	—	—	—	—
Interest payment	2,860	2,401	1,891	1,325	697	—	—	—	—	—
Principal payment	4,175	4,634	5,144	5,710	6,338	—	—	—	—	—
Property taxes	360	299	274	259	248	230	216	209	198	180
Insurance	198	166	151	144	137	126	119	115	108	101
Total ownership costs	17,593	7,499	7,460	7,438	7,420	356	335	324	306	281
Operating costs:										
Fuel	700	704	707	711	714	718	721	715	728	732
Labor	3,049	3,064	3,079	3,094	3,110	3,125	3,141	3,157	3,173	3,188
Repairs	1,065	1,506	1,844	2,130	2,381	2,608	2,817	3,012	3,195	3,367
Baling twine	7,056	7,056	7,056	7,056	7,056	7,056	7,056	7,056	7,056	7,056
Total operating costs	11,869	12,329	12,687	12,991	13,261	13,508	13,736	13,950	14,152	14,344
Total costs:	29,462	19,828	20,146	20,429	20,681	13,864	14,071	14,274	14,458	14,625
Deductible expenses:										
Depreciation	3,856	6,887	5,411	4,410	4,410	4,410	4,410	2,207	—	—
Interest	2,760	2,401	1,891	1,325	697	—	—	—	—	—
Property taxes	360	299	274	259	248	230	216	209	198	180
Insurance	198	166	151	144	137	126	119	115	108	101
Operating costs	11,869	12,329	12,687	12,991	13,261	13,508	13,736	13,950	14,152	14,344
Total deductions	19,143	22,081	20,413	19,129	18,754	18,274	18,481	16,480	14,458	14,625
Tax savings	5,360	6,183	5,716	5,356	5,251	5,117	5,175	4,615	4,048	4,095
Salvage value	—	—	—	—	—	—	—	—	—	10,000
Depreciated value	—	—	—	—	—	—	—	—	—	0
Capital gain/loss	—	—	—	—	—	—	—	—	—	10,000
Tax on gain/write-off	—	—	—	—	—	—	—	—	—	2,800
Total after-tax costs:	24,102	13,646	14,430	15,073	15,430	8,747	8,896	9,659	10,410	3,330
Net present value	80,821									
Equiv. annual annuity	13,724									

Assumptions:
To bale 500 acres 7 times a year requires 350 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.
To calculate cost of bailing twine, baler is assumed to operate at 192 bales/hour.

Fuel Use: 2.5 gallons/hour
Fuel Price: .80 dollars/gallon
Labor Rate: 6.50 dollars/hour

Table 6. Annual Ownership & Operating Costs: New Balewagon

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	25,000	----	----	----	----	----	----	----	----	----
Unpaid Balance	49,000	41,132	32,399	22,705	11,944	----	----	----	----	----
Annual loan pmt.	13,258	13,258	13,258	13,258	13,258	----	----	----	----	----
Interest payment	5,390	4,525	3,564	2,497	1,314	----	----	----	----	----
Principal payment	7,868	8,733	9,694	10,760	11,944	----	----	----	----	----
Property taxes	740	614	562	533	511	474	444	429	407	370
Insurance	407	340	311	296	281	259	244	237	222	207
Total ownership costs	39,405	14,213	14,131	14,087	14,050	733	688	666	629	577
Operating costs:										
Fuel	932	937	941	946	951	956	960	965	970	975
Labor	2,029	2,040	2,050	2,060	2,070	2,081	2,091	2,102	2,112	2,123
Repairs	463	702	895	1,064	1,217	1,357	1,489	1,613	1,731	1,844
Total operating costs	3,425	3,678	3,887	4,070	4,238	4,393	4,540	4,679	4,813	4,941
Total costs:	42,830	17,891	18,018	18,157	18,287	5,126	5,228	5,345	5,442	5,518
Deductible expenses:										
Depreciation	7,925	14,156	11,122	9,065	9,065	9,065	9,065	4,536	----	----
Interest	5,390	4,525	3,564	2,497	1,314	----	----	----	----	----
Property taxes	740	614	562	533	511	474	444	429	407	370
Insurance	407	340	311	296	281	259	244	237	222	207
Operating costs	3,425	3,678	3,887	4,070	4,238	4,393	4,540	4,679	4,813	4,941
Total deductions	17,887	23,314	19,446	16,461	15,408	14,191	14,293	9,882	5,442	5,518
Tax savings	5,008	6,528	5,445	4,609	4,314	3,973	4,002	2,767	1,524	1,545
Salvage value	----	----	----	----	----	----	----	----	----	25,000
Depreciated value	----	----	----	----	----	----	----	----	----	0
Capital gain/loss	----	----	----	----	----	----	----	----	----	25,000
Tax on gain/write-off	----	----	----	----	----	----	----	----	----	7,000
Total after-tax costs:	37,821	11,363	12,573	13,548	13,973	1,152	1,226	2,579	3,918	-14,027
Net present value	68,623									
Equiv. annual annuity	11,652									

Assumptions:
To roadside 500 acres 7 times a year requires 233 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.

Fuel Use: 5 gallons/hour
Fuel Price: .80 dollars/gallon
Labor Rate: 6.50 dollars/hour

Table 7. Annual Ownership & Operating Costs: New Tractor, 40 HP

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	5,000	—	—	—	—	—	—	—	—	—
Unpaid Balance	15,000	12,591	9,918	6,950	3,656	—	—	—	—	—
Annual loan pmt.	4,059	4,059	4,059	4,059	4,059	—	—	—	—	—
Interest payment	1,650	1,385	1,091	765	402	—	—	—	—	—
Principal payment	2,409	2,673	2,968	3,294	3,656	—	—	—	—	—
Property taxes	200	166	152	144	138	128	120	116	110	100
Insurance	110	92	84	80	76	70	66	64	60	56
Total ownership costs	9,369	4,317	4,295	4,283	4,273	198	186	180	170	156
Operating costs:										
Fuel	5,120	5,146	5,171	5,197	5,223	5,249	5,276	5,302	5,328	5,355
Labor	0	0	0	0	0	0	0	0	0	0
Repairs	746	1,393	2,006	2,599	3,177	3,744	4,301	4,850	5,393	5,929
Total operating costs	5,866	6,538	7,178	7,796	8,400	8,993	9,577	10,152	10,721	11,284
Total costs:	15,235	10,855	11,472	12,079	12,673	9,191	9,763	10,332	10,891	11,440
Deductible expenses:										
Depreciation	2,142	3,826	3,006	2,450	2,450	2,450	2,450	1,226	—	—
Interest	1,650	1,385	1,091	765	402	—	—	—	—	—
Property taxes	200	166	152	144	138	128	120	116	110	100
Insurance	110	92	84	80	76	70	66	64	60	56
Operating costs	5,866	6,538	7,178	7,796	8,400	8,993	9,577	10,152	10,721	11,284
Total deductions	9,968	12,008	11,511	11,235	11,467	11,641	12,213	11,558	10,891	11,440
Tax savings	2,791	3,362	3,223	3,146	3,211	3,260	3,420	3,236	3,050	3,203
Salvage value	—	—	—	—	—	—	—	—	—	5,000
Depreciated value	—	—	—	—	—	—	—	—	—	0
Capital gain/loss	—	—	—	—	—	—	—	—	—	5,000
Tax on gain/write-off	—	—	—	—	—	—	—	—	—	1,400
Total after-tax costs:	12,444	7,493	8,249	8,933	9,462	5,932	6,343	7,096	7,842	4,637
Net present value	48,828									
Equiv. annual annuity	8,291									

Assumption:
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.

D. Operating Costs

All expected operating costs were adjusted annually for inflation. The labor rate used for an equipment operator ranged across regions from $7.50 to $9.38 per hour, the rate for field labor varied from $5 to $7 per hour (both include a 34% benefits margin). All four harvest operations required one equipment operator, charged to the relevant machine. The rake and baler operators were assumed to be driving the tractor pulling the equipment. Fuel use was calculated from the use per hour and harvest capacity listed in Table 1 for each piece of equipment. The cost of diesel was assumed to be $.80 per gallon. Repair costs were calculated using the following formula taken from the *American Society of Agricultural Engineers Standards Yearbook 1990:*

1) $C_{rm} = (RF1)P(h/1000)^{RF2}$

where

C_{rm} = accumulated repair and maintenance costs,
RF1,2= repair and maintenance factors from the ASAE Agricultural Machinery Management Data,
P = machine purchase price in current dollars, and
h = accumulated hours of use.

E. Baling twine

A three-twine baler is assumed with a twine cost of $21.50 per box (for approximately 200 bales).

F. Depreciation

The tax code allows farm machinery to be depreciated as 7-year property under the Alternate Depreciation System of the Modified Accelerated Cost Recovery System. Therefore, the purchase cost is multiplied by the standard percentages: 1st year 10.71, 2nd year 19.13, 3rd 15.03, 4th through 7th 12.25, and 8th year 6.13.

G. Tax Savings

This is the amount that taxes are reduced by writing off all deductible expenses. It equals the total deductions times the tax rate. To simplify the analysis, only federal rates were used in this study, but the tax rate used by an individual should include both federal and state brackets.

H. Salvage Value

The expected values used here are average estimates for the equipment after 3000 to 5000 hours of use based on survey results.

I. Depreciated Value

This value (also called the "book value") is the difference between the original purchase price and the sum of all depreciation taken on an asset. It represents what the asset is worth, in an accounting sense, if sold at that point in time.

J. Capital Gain/Loss & Tax/Write-off

These values are used to adjust for the fact that an asset's depreciated ("book") value is rarely equal the actual market value received when an asset is sold. The difference between the salvage value and the depreciated value of an asset is a capital gain, if positive, or a capital loss, if negative. Capital gains are taxed like ordinary income. Capital losses are a tax write-off just like other deductible expenses.

K. Net Present Value

This is the sum of all discounted after-tax costs over the period the equipment is held. It represents the total costs expressed in terms of the current purchasing power of the dollar amounts.

L. Equivalent Annual Annuity

This conceptual value represents the average of discounted costs per year (Van Horne). In this study, if the uneven annual cash flows included in the total after-tax costs of owning equipment could be lumped together and amortized over the ten year period, this is the fixed amount of costs which would have to be paid each year.

Table 7 presents the results for a tractor used to pull the rake and the baler pro-rated to accurately reflect the expected costs of harvesting. The values in the table were calculated based on 2000 hours of use per year (8 hours per day times 250 days per year). This approximates the cost of full-time use of a tractor. Since a tractor can be used for other tasks on a farm, only that portion of a tractor's available time which is actually applied to harvesting hay should be charged to the harvesting operation. Therefore, in this study the expected annual cost of a tractor (the equivalent annual annuity in Table 7) is pro-rated to the hay harvesting operation according to the percentage of available hours which are used in pulling the hay rake and baler each year. For example, to harvest 500 acres of hay with seven cuttings requires 233 hours of raking and 350 hours of baling each year, meaning that 29% of a tractor is required annually [(233 + 350)/2000 = 29%].

Used Equipment

The method presented in Tables 3 through 7 for new equipment was also used to find the equivalent annual annuity for used equipment. Tables 8 through 11 present these results. In the analysis, the fuel and labor costs are the same for the new and used equipment. The ownership costs and the repair costs are different for the two teams of equipment and there is no salvage value for used equipment. The same general assumptions are made for calculating the cost of used equipment as were made for the new equipment. That is, the grower intends to keep the harvest equipment ten years while harvesting 500 acres annually, pays 11% interest and has a marginal tax rate of 28%. This grower is expected to face after-tax total annual costs of $32,664 expressed in current dollars as the equivalent annual annuity for the five pieces of equipment.

A few points need to be raised concerning the calculation of the expected cost of used equipment. First, the repair costs are calculated using the formula given in equation 1, but it is expected that actual costs could range more widely around the average value calculated for an older machine than for a newer model (Hardesty and Carman). In some cases, growers reported costs much higher and much lower than the calculated average value for particular years. Second, it was assumed that machines purchased as used equipment have no salvage value after their normal life span, but this may not be true for well-maintained equipment. Higher salvage values reduce the net cost of owning equipment. Finally, many operators reported that they have extra pieces of equipment kept as a source for parts used to keep their newest machine(s) running. The cost of this "cannibalizing" approach is difficult to estimate, but clearly raises the real cost of repairs being incurred by a significant amount.

Factors Affecting the Costs of New and Used Equipment

Table 12 presents a summary of estimates of annual costs of owning and operating new and used harvest equipment, expressed as equivalent annual annuities. The estimates vary depending on four factors: acreage harvested, interest rate, tax rate and the length of time equipment is held.

Table 8. Annual Ownership & Operating Costs: Used 14' Swather

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	5,250	----	—	----	----	----	----	----	----	---
Unpaid Balance	15,750	13,221	10,414	7,298	3,839	----	----	----	----	—
Annual loan pmt.	4,261	4,261	4,261	4,261	4,261	----	---	—	----	---
Interest payment	1,733	1,454	1,146	803	422	---	—	—	—	---
Principal payment	2,529	2,807	3,116	3,459	3,839	—	—	—	—	—
Property taxes	210	174	160	151	145	134	126	122	116	105
Insurance	116	97	88	84	80	74	69	67	63	59
Total ownership costs	9,837	4,532	4,509	4,497	4,486	208	195	189	179	164
Operating costs:										
Fuel	1,399	1,406	1,413	1,420	1,427	1,435	1,442	1,449	1,456	1,463
Labor	5,078	5,103	5,129	5,154	5,180	5,206	5,232	5,258	5,285	5,311
Repairs	2,094	2,250	2,399	2,542	2,680	2,813	2,943	3,068	3,191	3,310
Total operating costs	8,571	8,759	8,941	9,117	9,288	9,454	9,617	9,776	9,931	10,084
Total costs:	18,408	13,292	13,450	13,614	13,774	9,662	9,812	9,965	10,110	10,248
Deductible expenses:										
Depreciation	2,249	4,017	3,156	2,573	2,573	2,573	2,573	1,287	—	—
Interest	1,733	1,454	1,146	803	422	----	----	—	----	---
Property taxes	210	174	160	151	145	134	126	122	116	105
Insurance	116	97	88	84	80	74	69	67	63	59
Operating costs	8,571	8,759	8,941	9,117	9,288	9,454	9,617	9,776	9,931	10,084
Total deductions	12,878	14,502	13,491	12,727	12,507	12,235	12,384	11,252	10,110	10,248
Tax savings	3,606	4,061	3,777	3,564	3,502	3,426	3,468	3,151	2,831	2,869
Salvage value	---	—	—	---	—	----	---	—	----	0
Depreciated value	---	—	----	----	—	---	----	—	---	0
Capital gain/loss	----	----	----	----	----	—	----	----	—	0
Tax on gain/write-off	----	----	----	----	----	---	---	---	---	0
Total after-tax costs:	14,802	9,231	9,673	10,050	10,272	6,236	6,344	6,814	7,279	7,379
Net present value	55,408									
Equiv. annual annuity	9,408									

Assumptions:
To swath 500 acres 7 times a year requires 583 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.

Fuel Use:	3	gallons/hour
Fuel Price:	.80	dollars/gallon
Labor Rate:	6.50	dollars/hour

Table 9. Annual Ownership & Operating Costs: Used Wheel Rake

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	1,375	---	---	---	---	---	---	---	---	---
Unpaid Balance	4,125	3,463	2,727	1,911	1,005	---	---	---	---	---
Annual loan pmt.	1,116	1,116	1,116	1,116	1,116	---	---	---	---	---
Interest payment	454	381	300	210	111	---	---	---	---	---
Principal payment	662	735	816	906	1,005	---	---	---	---	---
Property taxes	55	46	42	40	38	35	33	32	30	28
Insurance	30	25	23	22	21	19	18	18	17	15
Total ownership costs	2,576	1,187	1,181	1,178	1,175	54	51	50	47	43
Operating costs:										
Fuel	0	0	0	0	0	0	0	0	0	0
Labor	2,029	2,040	2,050	2,060	2,070	2,081	2,091	2,102	2,112	2,123
Repairs	359	368	376	385	393	401	409	416	424	431
Total operating costs	2,388	2,407	2,426	2,445	2,463	2,481	2,500	2,518	2,536	2,554
Total costs:	4,965	3,594	3,607	3,622	3,638	2,536	2,551	2,567	2,583	2,597
Deductible expenses:										
Depreciation	589	1,052	827	674	674	674	674	337	---	---
Interest	454	381	300	210	111	---	---	---	---	---
Property taxes	55	46	42	40	38	35	33	32	30	28
Insurance	30	25	23	22	21	19	18	18	17	15
Operating costs	2,388	2,407	2,426	2,445	2,463	2,481	2,500	2,518	2,536	2,554
Total deductions	3,516	3,911	3,618	3,390	3,306	3,210	3,225	2,904	2,583	2,597
Tax savings	985	1,095	1,013	949	926	899	903	813	723	727
Salvage value	---	---	---	---	---	---	---	---	---	0
Depreciated value	---	---	---	---	---	---	---	---	---	0
Capital gain/loss	---	---	---	---	---	---	---	---	---	0
Tax on gain/write-off	---	---	---	---	---	---	---	---	---	0
Total after-tax costs:	3,980	2,499	2,594	2,673	2,712	1,637	1,648	1,754	1,859	1,870
Net present value	14,697									
Equiv. annual annuity	2,496									

Assumptions:
To rake 500 acres 7 times a year requires 233 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.

Fuel Use: 0 gallons/hour
Fuel Price: .80 dollars/gallon
Labor Rate: 6.50 dollars/hour

Table 10. Annual Ownership & Operating Costs: Used Baler, Pull-Type

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	3,625	----	----	----	----	----	----	----	----	----
Unpaid Balance	10,875	9,129	7,191	5,039	2,651	----	----	----	----	----
Annual loan pmt.	2,942	2,942	2,942	2,942	2,942	----	----	----	----	----
Interest payment	1,196	1,004	791	554	292	----	----	----	----	----
Principal payment	1,746	1,938	2,151	2,388	2,651	----	----	----	----	----
Property taxes	145	120	110	104	100	93	87	84	80	73
Insurance	80	67	61	58	55	51	48	46	44	41
Total ownership costs	6,792	3,130	3,114	3,105	3,1098	144	135	131	123	113
Operating costs:										
Fuel	700	704	707	711	714	718	721	725	728	732
Labor	3,049	3,064	3,079	3,094	3,110	3,125	3,141	3,157	3,173	3,188
Repairs	1,327	1,395	1,459	1,521	1,580	1,637	1,693	1,746	1,798	1,848
Baling twine	7,056	7,056	7,056	7,056	7,056	7,056	7,056	7,056	7,056	7,056
Total operating costs	12,131	12,218	12,301	12,382	12,460	12,536	12,611	12,684	12,755	12,825
Total costs:	18,924	15,347	15,415	15,487	15,558	12,680	12,746	12,814	12,878	12,938
Deductible expenses:										
Depreciation	1,553	2,774	2,179	1,776	1,776	1,776	1,776	889	----	----
Interest	1,196	1,004	791	554	292	----	----	----	----	----
Property taxes	145	120	110	104	100	93	87	84	80	73
Insurance	80	67	61	58	55	51	48	46	44	41
Operating costs	12,131	12,218	12,301	12,382	12,460	12,536	12,611	12,684	12,755	12,825
Total deductions	15,105	16,183	15,443	14,875	14,683	14,456	14,522	13,703	12,878	12,938
Tax savings	4,230	4,531	4,324	4,165	4,111	4,048	4,066	3,837	3,606	3,623
Salvage value	----	----	----	----	----	----	----	----	----	0
Depreciated value	----	----	----	----	----	----	----	----	----	0
Capital gain/loss	----	----	----	----	----	----	----	----	----	0
Tax on gain/write-off	----	----	----	----	----	----	----	----	----	0
Total after-tax costs:	14,694	10,816	11,091	11,322	11,446	8,632	8,680	8,977	9,272	9,315
Net present value	63,974									
Equiv. annual annuity	10,863									

Assumptions:
To bale 500 acres 7 times a year requires 350 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.
To calculate cost of baling twine, baler is assumed to operate at 192 bales/hour.

Fuel Use: 2.5 gallons/hour
Fuel Price: .80 dollars/gallon
Labor Rate: 6.50 dollars/hour

Table 11. Annual Ownership & Operating Costs: Used Balewagon

Year:	1	2	3	4	5	6	7	8	9	10
Ownership costs ($):										
Downpayment	8,125	---	---	---	---	---	---	---	---	---
Unpaid Balance	24,375	20,461	16,117	11,294	5,942	---	---	---	---	---
Annual loan pmt.	6,595	6,595	6,595	6,595	6,595	---	---	---	---	---
Interest payment	2,681	2,251	1,773	1,242	654	---	---	---	---	---
Principal payment	3,914	4,344	4,822	5,353	5,942	---	---	---	---	---
Property taxes	325	270	247	234	224	208	195	189	179	163
Insurance	179	150	137	130	124	114	107	104	98	91
Total ownership costs	15,224	7,014	6,979	6,959	6,943	322	302	293	276	254
Operating costs:										
Fuel	932	937	941	946	951	956	960	965	970	975
Labor	2,029	2,040	2,050	2,060	2,070	2,081	2,091	2,102	2,112	2,123
Repairs	1,159	1,197	1,234	1,270	1,306	1,341	1,375	1,409	1,442	1,475
Total operating costs	4,120	4,173	4,225	4,276	4,327	4,377	4,426	4,476	4,524	4,572
Total costs:	19,344	11,187	11,203	11,235	11,270	4,699	4,729	4,768	4,800	4,826
Deductible expenses:										
Depreciation	3,481	6,217	4,885	3,981	3,981	3,981	3,981	1,992	---	---
Interest	2,681	2,251	1,773	1,242	654	---	---	---	---	---
Property taxes	325	270	247	234	224	208	195	189	179	163
Insurance	179	150	137	130	124	114	107	104	98	91
Operating costs	4,120	4,173	4,225	4,276	4,327	4,377	4,426	4,476	4,524	4,572
Total deductions	10,786	13,060	11,266	9,864	9,309	8,680	8,710	6,760	4,800	4,826
Tax savings	3,020	3,657	3,154	2,762	2,607	2,430	2,439	1,893	1,344	1,351
Salvage value	---	---	---	---	---	---	---	---	---	0
Depreciated value	---	---	---	---	---	---	---	---	---	0
Capital gain/loss	---	---	---	---	---	---	---	---	---	0
Tax on gain/write-off	---	---	---	---	---	---	---	---	---	0
Total after-tax costs:	16,324	7,530	8,049	8,473	8,663	2,268	2,290	2,875	3,456	3,475
Net present value	43,564									
Equiv. annual annuity	7,497									

Assumptions:
To roadside 500 acres 7 times a year requires 233 hours of use.
Repair costs are calculated using the functional form outlined in the 1990 ASAE Standards Index.
Labor rates include a 34% mark-up to reflect benefits.

Fuel Use: 5 gallons/hour
Fuel Price: .80 dollars/gallon
Labor Rate: 6.50 dollars/hour

The acreages reported in Table 12 represent three scales of operation across the range which can be handled by a single equipment team, ignoring agronomic constraints. With the harvesting capacities reported in Table 1, a single team of equipment could cover as much as seven cuttings of 2000 acres of alfalfa hay during the year-long harvest period usual to California. However, constraints placed on the timing of harvest operations due to weather conditions (e.g. dew for baling or raking) reduce the number of acres that can be harvested with one team of equipment. Hence, one could realistically harvest about 1,000 acres with one team of equipment (two balers would be needed in areas with shorter baling windows).[3] An operation of 500 acres would use the new equipment's expected number of productive hours over the 10 to 20-year life span that manufacturers claim for their machines. Operations of 200 acres are common in California when hay is planted as a rotation crop. The effect of acreage on costs of both new and used equipment is quite apparent in Table 12: total costs increase, but costs per acre decrease with increasing acreage. Clearly,

Table 12. Equivalent Annual Annuity of Purchasing New and Used Equipment

Interest Rate (%)	New Equipment Tax Rate 15%	New Equipment Tax Rate 28%	New Equipment Tax Rate 33%	Used Equipment Tax Rate 15%	Used Equipment Tax Rate 28%	Used Equipment Tax Rate 33%
200 Acres Harvested Each Year for 10 Years						
7	$32,350	$27,746	$25,975	$22,778	$19,424	$18,135
9	34,593	29,742	27,876	23,609	20,163	18,838
11	36,872	31,766	29,803	24,466	20,924	19,562
13	39,183	33,816	31,752	25,349	21,705	20,303
500 Acres Harvested Each Year for 10 Years						
7	$48,198	$41,175	$38,475	$36,602	$31,140	$29,040
9	50,419	43,155	40,361	37,444	31,891	29,755
11	52,679	45,165	42,275	38,315	32,664	30,491
13	54,974	47,203	44,214	39,212	33,459	31,246
1000 Acres Harvested Each Year for 10 Years						
7	$73,338	$62,481	$58,305	$60,206	$51,145	$47,659
9	75,547	64,453	60,186	61,074	51,919	48,398
11	77,799	66,459	62,097	61,973	52,720	49,161
13	80,090	68,495	64,036	62,902	53,543	49,944
1000 Acres Harvested Each Year for 5 Years						
7	$80,764	$68,852	$64,270	$62,238	$52,891	$49,296
9	83,038	70,886	66,212	63,268	53,804	50,164
11	85,320	72,920	68,150	64,304	54,719	51,032
13	87,609	74,954	70,086	65,344	55,635	51,900

[3] Most growers would prefer to have two swathers, two rakes, two balers, and one balewagon per 1,000 acres. This provides greater flexibility, the harvester is not forced to adhere to as exact a schedule, and allows some time for equipment repairs.

being able to spread fixed ownership costs over more acreage is an advantage of large growers.

Interest rates and tax rates have opposite effects on equipment costs. As would be expected, interest rates and equipment costs change in the same direction. An increase in interest rates raises the cost of equipment and, therefore, reduces all firms' incentive to buy. Income tax rates, on the other hand, reduce the after-tax cost of equipment. This appears to indicate that more profitable firms (if they have tax rates higher than less profitable firms) are more likely to buy equipment than are less profitable firms which harvest the same number of acres. This also means that equipment purchases may be more likely when alfalfa hay market prices improve, thus improving industry profitability. Of course, taxes also decrease the after tax cost of custom hiring, so no conclusion about the effects of taxes can be reached at this point in the analysis.

The length of time that equipment is kept before being replaced has some effect on annual costs. The interviews revealed that many growers keep equipment for less than ten years. Table 12, therefore, presents results for a five-year holding period which can be compared with results from the ten-year period used throughout the analysis. As is apparent in the bottom two sections of results in the table, shorter holding periods raise annual costs slightly. For operations of 1000 acres, the difference in annual annuities is approximately $5,000 to $6,000 for new equipment and $1,000 to $2,000 for used equipment. The reason for this result is that shorter holding periods have offsetting costs; average ownership costs increase, but average operating costs decrease due, primarily, to lower repair costs. In other words, over the life of equipment, the replacement decision involves the tradeoff between depreciation and repair costs. This is true for smaller acreage operations as well.

The Costs of Backup Equipment

Although 1000 or more acres could be harvested with a single team of equipment, many growers own additional pieces of equipment. Some growers facing agronomic constraints buy multiple pieces of equipment to enable them to operate within a narrow harvest "window". Other growers simply want extra machines as a "backup" in case of downtime.

The decision to purchase additional machinery raises the total and per acre costs of owning new or used equipment. As an example, Table 13 presents estimates of total annual harvest costs for a grower with 500 acres under different equipment capacities. The left column showing the costs of owning one of each type of harvest equipment is the base case from Table 12. In each column to the right of that case, a single piece of equipment is added to show how total annual costs increase. The amount of increase between columns equals the equivalent annual annuity of the cash ownership costs of the additional machine. Total operating costs do not change between columns because the same acreage is being split up across two machines. Clearly, owning backup equipment raises harvest costs significantly.

Comparing entries in Tables 12 and 13 for new versus used equipment, the general conclusion which can be reached is that used equipment costs less in all cases. It is noted in Table 12, however, that as interest rates decline the amount of the cost difference between new and used equipment declines also. Yet, evaluation of the two purchase alternatives requires a comparison of costs with custom harvest rates.

Table 13. The Annual Cash Costs of Backup Equipment (for 500 acres)

New Equipment	Number of Equipment Units in Team			
Swather	1	1	2	2
Rake	1	1	1	2
Baler	1	2	2	2
Balewagon	1	1	1	1
Total After-Tax Cost of Equipment Per Year	$45,165	$51,516	$60,721	$63,551

Used Equipment	Number of Equipment Units in Team			
Swather	1	1	2	2
Rake	1	1	1	2
Baler	1	2	2	2
Balewagon	1	1	1	1
Total After-Tax Cost of Equipment Per Year	$32,664	$35,229	$38,944	$39,917

Assuming 11% interest rates and a 28% tax bracket. The costs are the equivalent annual annuity. The costs of owning a tractor are included.

CUSTOM RATES

Custom rates for harvesting alfalfa hay are contracted on a varied basis. As shown in Table 14, custom operators in the different producing regions offer different options to growers at rates which can vary widely across the state. In some regions each of the four harvesting tasks can be custom hired separately or in package deals. In other regions, only roadsiding is offered separately while package deals are the norm for swathing, raking and baling. In the high desert, where there are many absentee growers, custom operators offer package deals including irrigation management total acreage, and sometimes charge for a minimum of one ton per acre per cutting.

The survey responses reported in Table 14 indicate that custom rates in the high desert are higher than those in the three valleys, which have very similar and marketing the hay after harvest. Custom rates are normally quoted by the acre for swathing and raking and by the bale or ton for baling and roadsiding.. Custom operators generally charge the same rate per ton regardless of rates. The lowest reported total annual gross cost

Table 14. Custom Rates for Alfalfa Hay Harvest

	Imperial Valley	High Desert	San Joaquin Valley	Sacramento Valley
Swath	$8.50/acre	$9.00/acre	$7.00/acre 6.00/ton	----
Rake	3.50/acre	3.50/acre	3.00/acre 3.00/ton	----
Bale	0.61/bale	1.00/bale	9.75 - 12.00/ton	----
Roadside	0.22/bale	0.25 - 0.30/bale	3.70 - 4.00/ton	$4.50/ton
Swath, rake, bale	----	----	----	23.00/ton
Swath and rake	12.00/acre	----	----	----
Bale and roadside	0.80/bale	----	----	----
Swath, rake, bale, and roadside	---- ----	---- ----	23.00 - 25.00/ton	23.00 - 24.00/ton
Swath, rake, bale, roadside, irrigation management*, sell	----	30.00/ton	----	----
Swath, rake, bale, roadside, sell	----	28.00 - 30.00/ton	----	----

* In this case, irrigation management means moving irrigation equipment and monitoring moisture so that the cutting is not too wet or too dry.

(with an annual yield of 8.4 tons) per acre in the high desert is approximately $235. The after-tax cost per acre is found to be approximately $200, $169 and $158, respectively, for the 15%, 28% and 33% tax brackets. For the Imperial Valley, San Joaquin Valley and Sacramento Valley, respectively, the lowest gross rates per acre are $192, $193 and $193 (assuming the same yield). The 28% tax bracket rates for the valleys are, respectively, $138, $139 and $139.

The total custom charge a grower would pay is calculated by multiplying the total acreage by the custom rate per acre. For example, a San Joaquin Valley grower in the 28% tax bracket with 500 acres yielding 8.4 tons annually would face a total after-tax custom charge of about $69,500 ($139/acre X 500 acres).

Comparing the results in Table 12 to the custom charges for any grower with rates and acreages corresponding to those in the table, it becomes clear that custom harvesting is the best alternative for growers on small acreages (100 to 300) but owning used equipment is the best choice on mid-to-large sized operations regardless of the interest rate or tax rate. The acreage at which the rankings of the three alternatives changes under various sets of assumptions is discussed in the next section.

BREAKEVEN ACREAGE

The breakeven acreage is the operation size for which the average total annual after-tax ownership (fixed) costs and operating (variable) costs for equipment is the same as the after-tax cost of custom hiring. The cost of owning and operating the equipment and the cost of custom hiring are described by equations 2 and 3, respectively.

2) after-tax ownership and operating cost = after tax ownership cost + after tax operating cost per acre times acres

3) after-tax custom hire cost = acres times after-tax custom rate per acre

$$\text{4) breakeven acreage} = \frac{\text{average after-tax ownership costs}}{\text{(after-tax custom rate per acre-after-tax operating cost per acre)}}$$

The breakeven acreage is calculated by setting the total after-tax cost of owning and operating equipment equal to the total after-tax cost of custom hiring and solving the equation for acreage. The result is equation 4 for breakeven acreage.

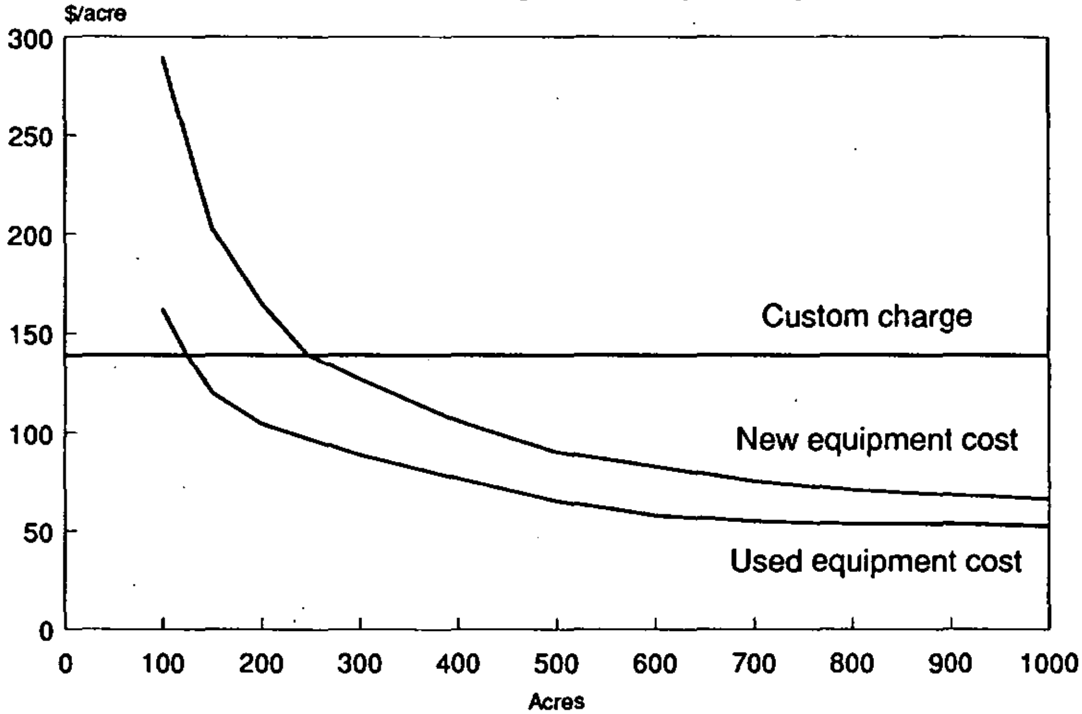
Table 15 presents the breakeven acreages calculated in this study. Three observations can be made. First, breakeven acreage varies depending on interest rates. Higher rates increase owning and operating costs, thus raising the amount of acreage across which those costs must be spread to remain competitive with custom rates. Second, the effects of tax rates are negligible (there are no differences in breakeven acreage between tax rates, therefore only one column is presented for new and used equipment in Table 15). Third, breakeven acreages are lower for used equipment than for new equipment. This is due to the fact that the total costs reported in Table 12 are lower for used machinery than for new equipment, and that both new and used equipment costs are compared to the single custom rate in calculating breakeven acreages.

Figure 1 is a graphic representation of the breakeven concept. The top curve is the total cost per acre to own and operate new equipment. The bottom curve is the total cost per acre to own and operate used equipment. Notice that the per acre cost decreases quickly for operations under 400 acres but that above 600 acres the curves smooth out indicating that the costs per acre are not decreasing much beyond this size. The harvest the hay in a timely fashion. The horizontal line across the graph is the per acre custom charge at the assumed annual yield of 8.4 tons per acre. The points where the curves showing the cost of ownership intersect the line showing the custom charge are the breakeven acreages for the relevant type of equipment.

A preliminary decision could be reached from the results in Figure 1 and Table 15. For example, an alfalfa hay producer in the San Joaquin Valley facing 11% interest rates on loans would always choose to buy used, rather than new, equipment but only if they had about 110 acres or more to harvest. However, as is usually the case in agribusiness, decisions cannot be made solely on the basis of anticipated economic conditions. Financial analysis always needs to consider unanticipated conditions, as described next.

Figure 1: Cost of Owning vs. Custom Hire

Breakeven Acreage - San Joaquin Valley



Assumptions: 8.4 ton/acre yield, 11% interest and 28% tax bracket

Table 15. Breakeven Acreages for Buying New and Used Harvest Equipment at Varying Interest Rates

Region	Interest Rate (%)	New Equipment	Used Equipment
Imperial Valley	7	212	94
	9	231	103
	11	251	112
	13	271	120
High Desert	7	161	71
	9	175	77
	11	190	84
	13	205	91
Central Valley	7	210	93
	9	229	102
	11	248	110
	13	268	119

Note: The lowest custom rates for the Sacramento and San Joaquin Valleys were identical, therefore, only one set of results are reported here for the entire "Central Valley."

The preliminary analysis performed thus far has assumed that the quantity and quality of alfalfa hay harvested does not depend on the selected alternative (ownership of either new or used equipment or custom hiring). Yet, there are some risks involved in harvesting which vary across the alternatives and may affect a grower's net revenues. These risk factors must be identified and quantified to complete the decision-making process.

The Risks in Harvesting

The first risk factor to be considered is the timing of cuttings (the "cutting schedule"). It is a popularly held belief that owning harvest equipment allows for greater flexibility in the timing of operations. Since moisture content and cutting frequency are important determinants of the quality of alfalfa hay, control over harvest timing can be very valuable. For example, when asked why he owns his equipment, a grower producing top quality hay for dairy and horse markets responded: "I used to use custom harvest, but the quality wasn't as good and it didn't sell as well." This comment reflects the perception of a problem associated with the difficulty of getting a definite time commitment from custom operators. Timing may affect both the quality and quantity of hay harvested, especially if the interval between cuttings is too long causing the nutritional quality of hay to decline. Reductions in either quality or quantity will decrease a grower's net revenue, effectively raising the cost of (custom) harvesting. Therefore, this "timing risk" factor is considered as an incentive to buy equipment for acreages smaller than the calculated breakeven levels, and to consider new equipment rather than used (to avoid repair delays).

The second factor, called "efficiency risk", is viewed as an incentive to custom harvest. It concerns the efficiency of the harvest operation. In general, a custom operator may be more skilled at operating specialized equipment and may move through the field more efficiently. The fixed price per ton for baling and roadsiding serves as an incentive for the custom operator to harvest quickly. For this reason, custom operators will try to minimize equipment downtime. An owner operator may not be as experienced in repairing the specialized harvest equipment, thus requiring more time to resume work and risking revenue losses as discussed previously. It was noted during the interviews that custom operators typically buy new equipment to reduce time and money spent on repairs. Also, custom operators often keep excess equipment capacity and salvage early because they "just can't afford the downtime."

Risk Analysis

After the preliminary analysis indicates which of the three alternatives is the least costly, choosing either of the other two alternatives indicates that the grower is willing to pay a risk premium to avoid some potential problems inherent in the "least cost" alternative. For some growers, this may be a rational decision once the risk factors are considered.

To illustrate risk analysis, the case of a San Joaquin Valley grower with 500 acres who pays 11 percent interest and who is in the 28 percent marginal tax bracket is presented as an example. For this grower, the preliminary analysis showed that the total annual cost of purchasing a single team of new equipment is $45,165, the annual cost of purchasing used equipment is $32,664, and custom costs total $69,500 per year. The preliminary decision for this grower is to buy used equipment. However, the grower is aware of the costs associated with the two risk factors identified above and wishes to incorporate them into his analysis.

The efficiency risk factor may raise the real cost of owning equipment. In this example, the preliminary financial analysis includes higher estimates of repair costs for used equipment than for new, yet the grower knows that repair delays may also cause lost revenues that would not be incurred with custom harvesting because custom operators often have extra machines available. Reduced quality (from sub-optimal moisture content or other such production risk), reduced quantity (due to irrigation delays after earlier cuttings), and reduced price (a market risk) all reduce total revenues. If such losses occur due to breakdowns of used equipment and, to a lesser extent, new equipment, revenue damage has to be included in the "cost of risk" of owning equipment. If, for example, the grower estimates that potential damage can include an average price reduction of $5 per ton and a 10% yield reduction due to repair delays for used equipment, the estimated annual cost of that used equipment must be raised by the cost of this risk factor, calculated[4] as

Cost of Risk = (Damage) x (Probability of occurrence)
= ($63,000)(.6)
= $37,800.

This indicates that with a probability of 60 percent, used-equipment downtime will cause revenue reductions totaling $37,800 each year. This raises the total risk-adjusted cost of used equipment to $32,664 + [($63,000).6] = $70,464 per year. The grower may also expect repair delays for new equipment to cause these revenue losses in 40 percent of the years it is operated, giving that alternative a cost of efficiency risk totaling $25,200 per year and a total cost of $45,165 + [($63,000).4)] = $70,365.

At this point, the risk analysis has changed the preliminary decision. The risk-adjusted cost of purchasing used equipment ($70,464) is now the highest of the three alternatives. The least expensive choice is now to custom harvest (costing $69,500). However, as noted earlier, the timing risk factor may affect the real cost of custom harvesting.

The risk factor concerning the timing of cuttings adds to the cost of custom harvesting. Since it is assumed that the grower would harvest at virtually the best time considering production and marketing conditions, if he had the equipment to do so, any variation from that harvest time which reduces total revenues collected from the crop is a "cost of risk" inherent in custom harvesting.[5]. In this example, the grower expects to suffer the same level of damage (revenue

[4]The total potential damage includes the price reduction ($5/t x 8.4/t/ac x 500 acres = $21,000) plus the yield reduction (0.1 x 8.4/t/ac x 500 acres x $100/t = $42,000). These estimates of price and yield losses are, of course, only forecasts which are based on the grower's experience; other growers may expect much lower damage potential.

[5]Another risk associated with custom hiring is the inflexibility of the schedule. For example, a grower doing his own harvesting can shift the harvest date to avoid inclement weather or to accommodate irrigation scheduling or other cultural operations. This is more difficult when the grower has his fields custom harvested.

loss) as described above for usedequipment if the custom operator does not harvest at the optimal time. The grower estimates that such suboptimal timing is likely to occur only once every 30 cuttings. Therefore, the estimated cost of custom harvesting needs to be raised by the cost of this risk factor, calculated as ($63,000) (1/30) = $2100. The real cost of custom harvesting in this example is now estimated to be $69,500 + 2100 = $71,600.

In this example, the effect of the timing risk factor elevated the option of purchasing new equipment to be the least cost alternative. The effects of other factors may or may not sway the final decision back in favor of buying used equipment or custom harvesting. The key is that all risk factors must be considered.

Whereas the preliminary decision is derived from observable quantities, the risk analysis portion of the decision process is based on estimates of both damages and the probabilities of those damages occurring. This means that the final decision is affected significantly by the skill of the grower in estimating the cost of risk for each potential risk factor Since this is an inexact process, many growers may prefer a different approach to the problem.

Instead of estimating the cost of risk to be added to each of the three harvest alternatives, the *risk premium* can be evaluated. The risk premium[6] in this study is simply the difference between an alternative's expected unadjusted financial cost and the expected cost of the least expensive alternative. In the example above, the alternatives of purchasing new equipment and custom harvesting both have a risk premium compared to purchasing used equipment. If the grower is considering the purchase of new equipment, the annual risk premium is $45,165 - 32,664 = $12,501. This means to justify the purchase, the grower must believe there are at least $12,501 worth of risks associated with purchasing used equipment that he wishes to avoid. It is not necessary to formally measure the risks, as suggested thus far in this section of the paper, an informal assessment may be enough to satisfy the grower. Therefore, this risk premium evaluation process is similar to the process involved in deciding whether or not to purchase insurance.

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[6] In the finance literature, a risk premium is an amount an investor (like an insurance company) receives for accepting some risk (Van Horne). In this study, the term refers to an amount a grower pays to eliminate some risk, thus it is similar to an insurance premium paid by an insurance policyholder.

ADDITIONAL RESTRICTIONS AND CONSIDERATIONS IN PURCHASE DECISIONS

A grower who is considering which equipment acquisition alternative to choose may face additional restrictions ignored thus far in the analysis. After performing the preliminary financial analysis and adjusting the results for costs of risk, a grower may be restricted from purchasing equipment due to constraints on his borrowing capacity and/or the opportunity costs of owning hay harvesting equipment, as explained below.

The total cost of purchasing new or used equipment may exceed a grower's borrowing capacity and, as a consequence, he cannot get the needed loan. First, the down payment required for most purchases is significant, $62,000 for new equipment and $23,375 for used equipment, and many growers may not have it in cash reserves. Second, the amount of the loan ($136,500 for new equipment) may raise a grower's total indebtedness beyond levels desired by lenders, causing them to approve only a smaller amount or deny the loan entirely.

There are significant opportunity costs of owning hay harvesting equipment. One mentioned often in the interviews is the time required to perform harvest tasks. A grower who believes it is easier and cheaper to custom harvest said: "You are out there all day and all night eight months out of the year. It is a headache and it just does not pay." Harvesting hay may prevent a grower from attending to other crops in his rotation, thus risking reduced revenues from those enterprises. Also, if hay is a rotation crop only, hay harvesting equipment may sit idle or be under-utilized in some years, raising the real cost per year. Therefore, even if a grower has the borrowing capacity to buy the equipment, opportunity costs of ownership may make custom harvesting a better financial decision.

Several additional factors need to be considered beyond the pure financial analysis of the different harvesting options. The relative importance of these factors may alter which option is "the best" for a particular alfalfa operation. This analysis indicated that purchasing used equipment costs less than new equipment or custom harvesting. However, one must consider the ease of finding, and the time required, to locate good used equipment. Many growers like to have a fleet of equipment that is the same make and model. This may be difficult to achieve when buying used equipment. Probably the greatest risk with used equipment, relative to new equipment or custom hiring, is the possibility of equipment downtime due to equipment failure and time lost during repairs. The advisability of used equipment may be dependent upon the mechanical ability of the grower or his employees and the willingness to allocate time to equipment repairs. To minimize the risk of downtime with used equipment, many growers opt to buy backup equipment or, in other words, they own more equipment than is actually needed for their acreage. The cost of this backup equipment should be included in the financial analysis of each harvesting option. Others may have an agreement or understanding with their neighbors and help each other during times of equipment failure.

SUMMARY AND CONCLUSIONS

The question of whether an alfalfa hay producer is better off owning harvesting equipment or custom hiring someone else to perform the job involves analyzing three alternate courses of action: (1) buy all new harvest equipment, (2) buy all used harvest equipment, and (3) custom hire the job done. Total and annual expected costs of owning and operating harvest equipment will vary depending on three factors: acreage harvested, interest rate, and tax rate. Cost estimates were made here for several combinations of these factors. Interest rates and tax rates are shown to have opposite effects on equipment costs. Higher interest rates raise the cost of equipment and, therefore, reduce all firms' incentive to buy. Higher tax rates, however, reduce the after-tax cost of equipment.

In comparing expected costs for new versus used equipment, the general conclusion is that used equipment costs less in all cases. This is not surprising considering that there is a thin, although active, market for used equipment in California. Of course, the timing and magnitude of the capital outlays is significantly different for new and used equipment and must be taken into account by the firm.

To choose between the three alternatives requires a comparison of expected purchase costs with custom harvest rates. This leads to an estimate of the breakeven acreage which is used as a decision criterion. In general, a grower would choose to buy equipment if his operation is larger than the breakeven acreage, and would custom harvest if his operation is smaller than the breakeven size. However, two risk factors need to be included in the decision process: the timing of cuttings and the efficiency of the harvest operation. Also, some growers may face financial constraints. The affect of these factors may significantly alter the "real" costs of owning versus custom hiring harvest equipment and, therefore, may change the decision reached by an individual grower.

There is clearly no "best" harvesting option for all farms producing alfalfa. The choice may be different depending on the scale of the operation, the diversity of the farm, and the relative importance of alfalfa in the farming enterprise. Custom harvesting is probably the best option for small farms where the alfalfa acreage falls below the breakeven acreage for owning equipment. Custom harvesting may be the best approach for diverse farming operations where alfalfa acreage fluctuates considerably from year to year. Alfalfa harvesting requires a substantial time commitment and the grower's time may be better spent on other more profitable commodities. Owning new equipment may be the best option for custom harvesters or large operations that because of rigid scheduling constraints simply cannot afford the downtime that can be associated with older equipment. Used equipment is probably the best option for medium-sized alfalfa operations where alfalfa plays a prominent role in the farm operation and the grower has the time and expertise to make repairs, or has replacement equipment to use during periods of equipment downtime. While there is obviously no single best harvesting option for all alfalfa operations, this analysis provides a baseline guide to evaluate the different alternatives.

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