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Machinery Combinations for Oklahoma Panhandle Grain Farms

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Machinery services represent one-third or more of the production costs for important Oklahoma crops. There are different ways to provide the machinery required to prepare the land and harvest the crops. Custom operators can be hired, machines can be owned and different sizes and kinds of implements and power can be used. It may be possible to decrease machinery costs on a given farm by careful evaluation and selection of machinery plans, to the extent that each alternative has a substantially different cost per unit of service.

Research reported herein was made to determine fixed and variable costs of farm machines; to specify optimum machinery combinations for different farms sizes, under a range of timeliness requirements for important jobs; and to compare owned and operated machine costs to custom operated costs in the Oklahoma Panhandle.

Cost data and analytical procedures are presented to evaluate potential savings and to select "least cost" machines or sets of machines.

Source of Data

Machinery performance and cost data were obtained from a 1960 survey of 57 farmers and 10 machinery dealers in the Oklahoma Panhandle. Farms surveyed were selected to include principal soil resource situations and farm sizes. Costs for individual machines were calculated from performance rate, repair cost, fuel and oil use, length of life and other basic data obtained in the surveys (see Appendix). Price data shown in Appendix Table II reflect approximate 1960 price levels.

Preharvest Machinery Requirements

Machinery requirements for a crop farm of a given size are determined primarily by: (a) the crop combination produced; (b) tilling practices for each crop; (c) calendar days during which field work is possible; and (d) the relationship of crop returns to calendar dates that field work is accomplished.

For this study, fixed crop combinations and tilling practices are assumed. Although use of cropland varies throughout the area, the

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farmer survey indicated that a "typical acre" of cropland included the following proportions: .208 acre of wheat on fallow; .26 acre of wheat on stubble; .324 acre of sorghum and .208 acre of fallow. Farms with varying cropland acres are assumed to produce crops in the proportion they occur in the typical acre. Usual tilling practices for each crop were obtained from the farmer survey and are presented in Table I.

Table I.—Machinery Practices for Crops in the Oklahoma Panhandle

	Wheat on Fallow*	Wheat on Stubble	Grain Sorghum
Chisel	1	1	0
Oneway	4	3	2
Blank list	0	0	1
Harrow	0	0	1
Drill	1	1	0
Plant	0	0	1
Cultivate	0	0	2

*Includes fallow operations.

The number of days suitable for field work was estimated from long-time weather records. Given the calendar period within which a job is to be done, weather data were used to estimate the number of days available for field work for selected probability levels. These data were used in calculating machinery requirements for given crops and practices.

A farm manager can choose the calendar period within which most farm operations are most profitably completed. For example, onewaying of wheat land can be accomplished anytime from harvest to drilling season. However, most Panhandle farmers prefer to complete the first onewaying between July 1 to July 15 or as soon after harvest as possible. Presumably, that time is chosen because the value of additional yields resulting from plowing in that period, rather than later, more than offsets the additional cost of plowing early. Thus, choice of another period would give lower net returns.

The term "timeliness" is used to indicate achievement of the most profitable job timing. Additional costs of timeliness usually represent costs of more machinery and hired labor required to do a job in a specified time period. The choice of calendar period determines machinery requirements, given crops, tilling practices and days suitable for field work in critical periods.

Data necessary for making the type of timeliness analysis described above can only be roughly estimated. Three machinery jobs for which farmers reported calendar period preferences and for which machinery time tends to be limited are: (1) plant grain sorghum—May 25-June 10; (2) combine wheat—June 20-June 30; and (3) plow grain sorghum the first time and oneway or chisel stubble the first time—July 1-July 15. Emergency operations designed to prevent wind erosion also are considered briefly.

Alternative Preharvest Machinery Combinations

Preharvest machinery combinations are described in Table II. Clearly, a number of machinery combinations is possible. The ones selected are illustrative of possibilities and provide different levels of machinery capacities for varying acreages of cropland and job timing restrictions. Set Number I is somewhat representative of usual machinery combinations found on typical farms in the Oklahoma Panhandle (about 640 cropland acres according to the farm survey). Use of new machines, traded for a salvage value equal to 20 percent of the new cost at the end of 10 years, is assumed in computing costs. Alternative sets involving used machines, used and new machines, tractor combinations of different sizes, and combinations of custom and ownership plans might also be considered for some farm sizes.

Estimates of total cropland acres which each machine can service in periods preferred by farmers, given the number of work days available, are presented in Table III. Capacities were estimated using the following assumptions:

(a) Calendar periods for all critical jobs are included,
(b) Work days are 10 hours long, and
(c) Performance rates presented in Appendix Table IV apply.

Probabilities of different numbers of work days are also presented in Table III.

Capacities of the two 5-plow and two 4-plow tractor combinations were limited by planting capacity for grain sorghum. Addition of another planter to these sets would increase potential acreages to those indicated for cultivating and onewaying during July 1-July 15. Capacities are identical for the two 4-plow and two 5-plow sets because planting rates were assumed limited by planting speed rather than power or tractor speed. Differential rates of onewaying with 3, 4, and 5 plow tractors gave different acreage limitations for sets using single tractors of those sizes. Capacities provided in Table III may be conservative because of the 10-hour work day assumption as jobs such as onewaying are almost a 24-hour operation. However, the 10-hour assumption allows flexibility for "down time", replanting and emergency operations.

As expectations about numbers of work days available in a given

Table II.—Composition, New Machine Cost and Investment for Different Sets of Preharvest Machinery[1]

	Set I		Set II		Set III		Set IV		Set V	
Item	Size	Cost	Size	Cost	Size	Cost	Size	Cost	Size	Cost
		($)		($)		($)		($)		($)
Tractor[2]	2-4 plow	7,814	1-4 plow	3,907	1-3 plow	3,492	2-5 plow	8,880	1-5 plow	4,440
Oneway	2-15 foot	2,324	1-15 foot	1,162	1-12 foot	1,050	2-15 foot	2,324	1-15 foot	1,162
Chisel	1-15 foot	966	1-15 foot	966	1-12 foot	600	1-15 foot	966	1-15 foot	966
Cultivator	1-4 row	493	1-4 row	493	1-2 row	315	1-4 row	493	1-4 row	493
Lister	1-4 row	690	1-4 row	690	1-2 row	335	1-4 row	690	1-4 row	690
Harrow	1-4 sec.	202	1-4 sec.	202	1-4 sec.	202	1-4 sec.	202	1-4 sec.	202
Drill	2 (16-10)	1,704	1 (16-10)	852	1 (16-10)	852	2 (16-10)	1,704	1 (16-10)	1,704
Total New Cost		14,193		8,272		6,846		15,259		9,657
Average Investment[2]		8,516		4,963		4,108		9,156		5,794

[1] Combines are not included as a part of any machine combination.

[2] Tractors were classified by draw bar horse-power ratings x.75 as follows:

5 plow (or 4 to 5 plow)	— 42-50 h.p.	3 plow	— 24-32 (—) h.p.
4 plow	— 32-41 (—) h.p.	2 plow	— less than 24 h.p.

[3] Average investment is obtained by adding salvage value and new cost and dividing the result by 2. Salvage value for all machines is considered to be 20% of new cost.

Table III.—Total Cropland Capacities of Alternative Machinery Combinations for Selected Numbers and Probabilities of Workdays in Calendar Periods Designated as Critical by Panhandle Farmers[1]

Machinery Combinations		May 25 — June 10				July 1 — July 15			
	Work days Available	17	14	12	9	15	13	11	8
	Percent of years	7	50	75	90	3	50	75	90
		Total Cropland Capacities (Acres)							
1-3 plow		1700	1400	1200	900	900	800	700	500
1-4 plow		2400	2000	1700	1300	1500	1200	1100	800
1-5 plow		2400	2000	1700	1300	1600	1400	1200	900
2-4 plow		2400	2000	1700	1300	3000	2600	2200	1600
2-5 plow		2400	2000	1700	1300	3000	2600	2200	1600

[1] Work days and probabilities were estimated from 30 years of weather records by using the following conditions to identify days in which field work would not be possible and subtracting the result from the total days in the period.

Rainfall	Field work days lost
.25 to .76 in.	1.5 days
.76 to 1.50 in.	2.5 days
1.51 in. or more	4.0 days

period are increased, the expected capacity of the machine increases. The difference between costs of the suggested set for a given number of work days and costs of the "least cost set" when timeliness is not considered provides an estimate of the cost of assuring the specified degree of timeliness. Probabilities of selected numbers of work days allow estimation of net gains in returns due to timeliness over a long period, assuming gross gains in total revenue from doing jobs in specified periods can be estimated.

Alternative Machinery Combination Costs

Figure 1 and Table IV show estimates of total preharvest costs per acre for five selected machinery combinations. Costs were calculated from individual machine cost data assuming $1.00 labor (see Appendix Table VI). Typical per acre costs of custom hiring all preharvest jobs also are shown in Figure 1. Some machine operations such as drilling,

Table IV.—Total Preharvest Cost Per Acre for Alternative Machinery Combinations, $1.00 Labor[1]

Cropland	Size and Number of Tractors				
Acres	1-3 plow	1-4 plow	1-5 plow	2-4 plow	2-5 plow
100	10.43	11.61	12.23	18.78	20.13
200	6.49	6.89	7.17	10.44	11.08
300	5.18	5.32	5.43	7.65	8.06
400	4.52	4.54	4.63	6.26	6.56
500	4.13	4.07	4.13	5.43	5.65
600	3.86	3.75	3.79	4.87	5.05
700	3.68	3.53	3.55	4.47	4.62
800	3.53	3.36	3.37	4.18	4.29
900	3.43	3.23	3.23	3.94	4.04
1000	2.34	3.12	3.11	3.76	3.84
1100	...	3.04	3.02	3.61	3.68
1200	...	2.97	2.94	3.48	3.54
1300	...	2.90	2.88	3.37	3.42
1400	...	...	2.82	3.23	3.32
1500	...	...	2.78	3.20	3.24
[2]	3.30	2.88	2.76	2.69	2.59

[1] Data used in computing per acre costs are as follows:

	Total Annual Fixed Cost ($)	Non Labor Variable Cost Per Acre ($/A.)	Labor Cost Per Acre @ $1.00/hr. ($/A.)
1-3 plow	787.95	1.41	1.14
1-4 plow	942.56	1.29	.89
1-5 plow	1,013.10	1.32	.78
2-4 plow	1,,669.14	1.26	.84
2-5 plow	1,810.22	1.29	.74

[2] As cropland acres covered per year are increased, a point is reached at which fixed cost per acre reaches a minimum (i.e., machines are worn out during the period of use and obsolescence cost is zero.) Since tractors are the most expensive and most heavily used equipment, the following levels of use reflect the acreage at which the estimated 12,000 hours of useful life in a tractor is exhausted in ten years of use (the usual trade-in age). Points of zero obsolenscence cost are as follows: 1 3-plow set, 1050 acres; 1 4-plow set, 1350 acres; 1 5-plow set, 1530 acres; 2 4-plow set, 2850 acres; and, 2 5-plow set, 3240 acres.

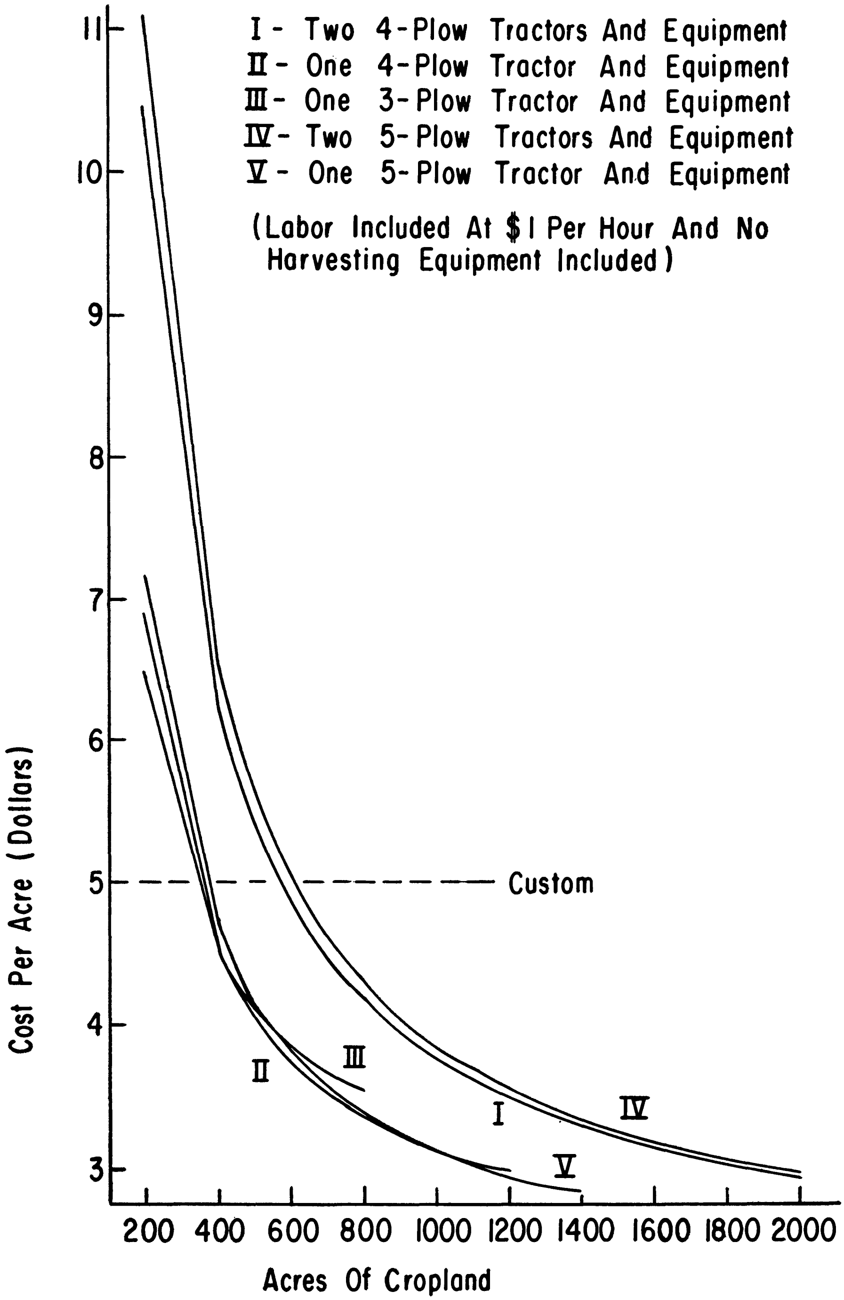

Figure 1. Total preharvest cost per acre for custom work and alternative machinery sets, Oklahoma Panhandle.

cultivating and planting were assumed to have fixed speed limits for a given implement size. Thus, larger tractors did not cut costs of those operations. Other jobs such as onewaying and chiseling allow use of speed and power of larger machines and result in economies for larger tractors at high acreages. Performance rates for various tractor-implement combinations are given in Appendix Table IV.

Least Cost Machinery Sets

Machinery combinations having lowest preharvest costs per acre and allowing farmers to plant grain sorghum, plow grain sorghum (first time) and oneway stubble (first time) within preferred periods in an expected 50 percent of years are as follows:

a. Custom hiring—0 to 300 acres of cropland.
b. One 3-plow tractor and equipment—300 to 400 acres of cropland,
c. One 4-plow tractor and equipment—400 to 900 acres of cropland.
d. One 5-plow tractor and equipment—900 to 1,400 acres of cropland.,
e. Two 4-plow tractors and equipment—1,400 to 2,000 acres.

Custom operators must be available to perform jobs at prescribed times if the optimum range for hiring custom work is to prevail. Differences between costs of alternative combinations indicate that the additional cost of using a slightly larger tractor is relatively small. Thus, the tractor size decision is not critical. For example, although a 3-plow tractor is cheapest for 300-400 acres, additional expenses of only \$ .02 to \$ .14 per acre are incurred if a 4-plow (or \$ .11 to \$ .30 if a 5-plow) tractor is used. That is, annual expenses would increase a maximum of \$40 to \$90 if a 5-plow tractor is substituted for a 3-plow tractor. Thus, the cost of having additional capacity to provide flexibility in timing jobs and extra power for heavy work is apparently negligible.

Substantial savings appear possible by using the lowest cost source or level of machine services. Use of custom operators when readily available to farmers with less than 300 acres would apparently save as much as \$500 per year. Choice of the least costly number of tractors for farms with 600 to 900 cropland acres would save about \$650 per year, or \$.94 to \$1.12 per cropland acre. For example, use of two 4-plow tractors on 600 cropland acres would cost about \$4.87 per acre and use of one 4-plow tractor would cost about \$3.75 per acre. Information obtained in the Oklahoma Panhandle survey indicates that a reasonably typical farm of 640 acres would have two 4-plow tractors. Unless one of the tractors is old and kept for infrequent emergency use, the practice of owning and maintaining two tractors on one-section farms is quite costly.

Effects of Labor Prices on Machinery Combinations

Labor for machine operations typically comes from family or operator labor and from hiring. The cost of family and operator labor depends on: (a) availability of alternative uses, (b) possible returns from alternative uses, and (c) the subjective value of leisure or other activities. Thus, labor costs may vary from zero to very high prices. Effects of different labor prices on machinery costs are analyzed in this section.

Per acre labor requirements for a given machinery combination on a typical cropland acre in the Oklahoma Panhandle are constant for any range of acreages. Thus, higher or lower labor costs simply raise or lower the cost curves in Figure 1 by a constant times the change in labor price. For example, .89 hours for a typical cropland acre is required for one 4-plow tractoı and equipment (see footnote to Table IV). Thus, labor at $1.00 per hour added $.89 to other costs in Figure 1. Free labor would reduce costs per acre of the 4-plow set $.89. A labor price of $1.50 per hour would cost an additional $.45 per acre (i.e. $.50 x .89). Different machinery sets require different amounts of labor. Thus, a labor price change would lower or raise cost curves of sets by different amounts. Table V shows effects of these changes on breakeven acreages for machinery sets. For example, the one 5-plow combination would replace the one 4-plow combination at 500 acres (rather than 900) of cropland if labor prices were $1.55 per hour (rather than $1.00 as assumed in Figure 2). Table V can be used to choose machinery sets for particular labor price situations, within restrictions of job timing. Breakeven labor prices only are provided for the probable ranges of machine substitution.

Table V.—Labor Prices Resulting in Equal Costs for Different Machinery Sets

Machine Set Comparisons	Acres of Cropland 300	400	500	600	700	1000	1200	1400	1600
	(Labor Costs—$/Hr.)								
1-3 plow cost = 1-4 plow cost	1.58	1.00	.76	---	---	---	---	---	---
1-3 plow cost = 1-5 plow cost	1.83	1.26	1.00	.79	.64	---	---	---	---
1-4 plow cost = 1-5 plow cost	2.41	1.88	1.55	1.34	1.19	.91	---	---	---
1-4 plow cost = 2-5 plow cost	---	---	---	---	---	1.90	1.64	1.45	1.30

Effect of Factors Influencing Job Timing

Table VI (Pages 18-19) provides data for analyzing machinery cost effects of expected work days and/or a desire for high assurance that a job will be completed in a given period. Optimum ranges for custom hiring all jobs and using one 3-plow tractor and equipment apply for all job requirements and workdays considered. However, as work day expectations are lowered (or the probability of completing a job in a given period is increased to .90) the one 5-plow set is substituted for the one 4-plow set on 800-850 cropland acre farms. Similarly, a two 4-plow set is substituted for the one 5-plow set at lower acreages as the expected number of work days is decreased (see Table VI).

Net Value of Timeliness

The cost of additional capacity incurred in substituting a two 4-plow set for a one 5-plow set would be about 60¢ per acre at the lower acreage range (i.e. \$3.94—3.30=\$.64, Table VI, Pc. 9,850 acres) or about \$500 per year. Weather records indicate that the additional capacity would be needed an average of one year in ten. In a ten-year period, the additional machinery cost would be about \$5,000 for an 850 cropland acres farm on which 221 (.26 x 850) acres of wheat and 275 (.324 x 850) acres of sorghum must be covered during the July 1-July 15 period. With net prices (e.g. after harvest costs are paid) of \$1.60 per bushel and \$1.40 per hundredweight for wheat and sorghum respectively, any combination of wheat losses per acre, X_1, and sorghum losses per acre, X_2, over a ten-year period such that $\$5{,}000 = \$1.60 \times 221X_1 + \$1.40\ 275X_2$ would pay the extra machinery cost for the period. For example, for $X_1 = X_2$, total losses of 6.76 bushels or hundredweight per acre over a ten-year period would pay the \$5,000 extra cost. An equipment set including older equipment or using custom operators may allow lower additional costs for the desired timing. Lower additional costs clearly allow lower expected per acre losses in yields.

Other Jobs Requiring Attention to Timing

Drilling wheat and controlling wind erosion on plowed wheat land by harrowing or light onewaying were cited by farmers as critical jobs requiring rapid completion. However, two drills can be pulled by 4 and 5-plow tractors and can be included in one tractor machinery sets on larger acreages. Although ability to cover wheat land rapidly to stop blowing is much greater with two tractors than with one, practices might be modified (i.e., strip only ½ or ¼ of the land surface) or working hours extended in lieu of maintaining otherwise excess capacity.

Future Farm Size Implications

Per-acre machinery costs decline rapidly in the 100 to 600 acres cropland farm range. In the short-run, low actual or reservation prices for labor, highly competitive custom operators, or machinery combinations involving used equipment could reduce differences in machinery costs on relatively small versus relatively large farms. For example, for short periods, operator labor and owned machinery may take any residual return available, greater than salvage value, and used machines may be maintained and operated by use of a high ratio of abundant labor to scarce capital. However, over longer periods, only custom hiring or innovations such as large volume rental services offer real promise in allowing small farms to compete with large farms in land or product markets. In the long-run, labor now on farms would be expected to move from small farms having high costs and low returns to higher paying alternatives. In any case, potential low total returns to labor and other resources on a small farm may be effective in causing a movement to larger farms or out of agriculture.

For farmers with 600 acres of cropland or more, opportunities for machinery combinations not considered here and differences in work preferences, managerial abilities, and supplies of family labor could result in essentially equal machinery costs. Thus, farms of quite different sizes in that range would have few machinery cost differences. Consequently, factors other than machinery economies appear to be the major determinants of long-run average farm sizes and ranges in sizes.

Combine Costs in the Panhandle

Estimated per-acre costs of 12, 14, and 16 foot, self-propelled combines are presented in Table VII and Figure 2. Costs include labor at $1.50 per hour, depreciation based on 8.5 years of useful life and a 20 percent salvage value, and other costs presented in Appendix Table VI. The relatively high labor price reflects expected scarcity of skilled combine labor during the harvest season. Assumptions used in computing depreciation reflect trade-in policies reported by Oklahoma Panhandle farmers and machinery dealers.

Cost advantages for a given acreage shown for the 12-foot combine over the 14- and 16-foot combines hold for substantially higher performance rates for the larger machines, higher labor prices, and lower initial cost differences between machines. If annual combine use is high enough to exhaust approximately 2,000 hours of total useful life in 8.5 years or less, costs of machines are approximately as follows: (a)

Table VII.—Estimated Costs Per Acre for Twelve, Fourteen, and Sixteen Foot Self-Propelled Combines With Labor at $1.50 Per Hour[1]

Acres	12 Foot Combine				14 Foot Combine				16 Foot Combine			
	No. of Days To Combine	Fixed Cost per Acre	Variable Cost/Acre	Total Cost/ Acre	No. of Days To Combine	Fixed Cost per Acre	Variable Cost/Acre	Total Cost/ Acre	No. of Days To Combine	Fixed Cost per Acre	Variable Cost/Acre	Total Cost/ Acre
		— Dollars —					— Dollars —				— Dollars —	
100	2.3	7.87	.79	8.66	2	8.65	.75	9.40	1.7	10.28	.70	10.98
200	4.6	3.94	.79	4.73	4	4.33	.75	5.08	3.4	5.14	.70	5.84
300	7.0	2.62	.79	3.41	6	2.88	.75	3.63	5.2	3.43	.70	4.13
400	9.3	1.97	.79	2.76	8	2.16	.75	2.91	6.9	2.57	.70	3.27
500	11.6	1.57	.79	2.36	10	1.73	.75	2.48	8.6	2.06	.70	2.76
600	14.0	1.31	.79	2.10	12	1.44	.75	2.19	10.3	1.71	.70	2.41
700	16.3	1.12	.79	1.91	14	1.24	.75	1.99	12.0	1.47	.70	2.17
800	18.6	.98	.79	1.77	16	1.08	.75	1.83	13.8	1.28	.70	1.98
900	21.0	.87	.79	1.66	18	.96	.75	1.71	15.5	1.14	.70	1.84
1000	23.3	.79	.79	1.58	20	.87	.75	1.62	18.2	1.03	.70	1.73

[1] Fixed costs and labor costs used are as follows:

	Annual Fixed Cost	Labor Cost/Acre
12 foot combine	$ 787	$.35
14 foot combine	865	.31
16 foot combine	1028	.26

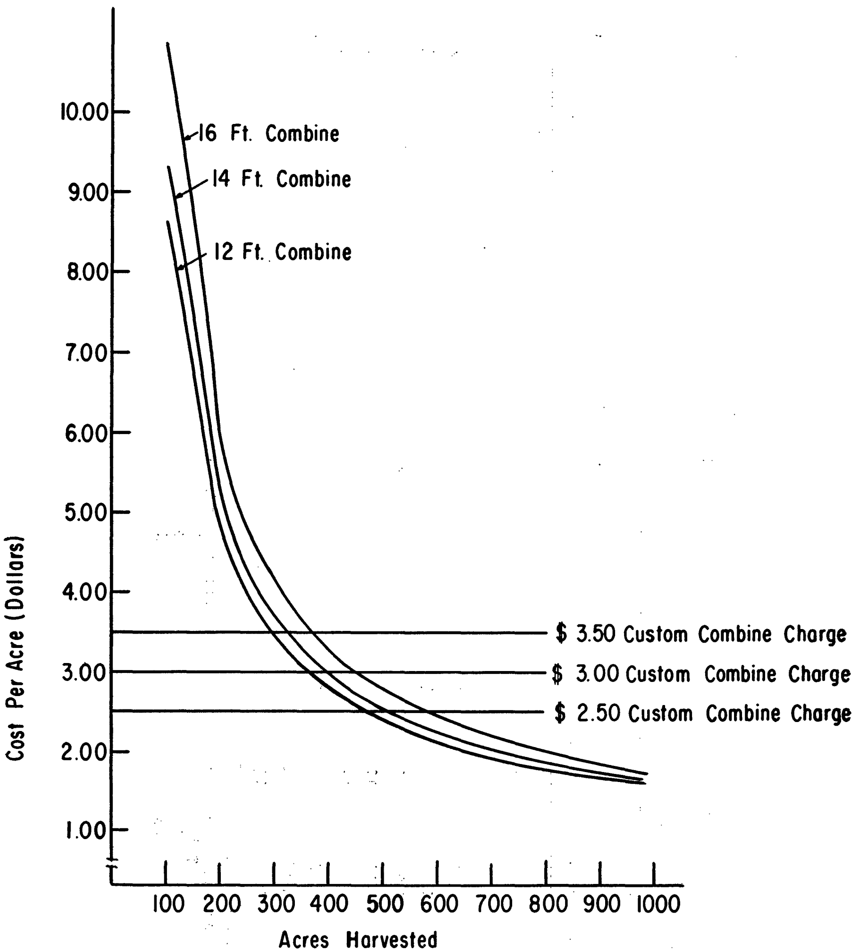

Figure 2. Estimated total costs per acre for different combine sizes and for custom work.

12-foot, 1,011 acres per year at $1.57 per acre; (b) 14-foot, 1,152 acres per year at $1.50 per acre; and (c) 16-foot, 1,364 acres per year at $1.45 per acre. Thus, custom operators and farmers with large acreages to combine over a fairly long calendar period have an incentive to buy the larger machines, other things—such as transportability—being equal.

If the number of days available for combining is not fixed, Figure 2 provides a direct basis for combine decisions. Choice of a 12-foot rather than a 14-foot combine would save only about $40 to $70 per year over 300 to 1000 acres. For the same range of acres, a 12-foot combine would save $150 to $190 per year, compared to a 16-foot combine. The additional costs of larger machines may be accepted as the "insurance costs" of completing a combining job in a shorter period by the numerous farmers who have purchased larger machines. Analysis of combine alternatives when "days to combine" are fixed is included in a later section.

Custom Hiring Versus Combine Ownership

Custom rates of $3.50, $3.00, and $2.00 per acre are included in Figure 2 to facilitate analysis of the custom-hire alternative. Breakeven acreages (the acreages at which the custom rate equals the ownership cost per acre) for a $3.00 custom rate are approximately 360, 385, and 445 acres for the 12-, 14-, and 16-foot machines, respectively. Breakeven combine acreages for other custom rates can be computed by use of Equation 1 and data from Table VII and Appendix Table VI.[1]

$$(1) \quad \frac{\text{Annual fixed combine costs}}{\text{Custom rate—annual cash combine costs}} = \text{Breakeven acres}$$

For example, the annual fixed cost for a 12-foot combine (see footnote one, Table VII) is estimated to be $787 per year and the annual cash cost is $.79 per acre. With a custom rate of $2.50:

$$\text{Breakeven acres} = 460 = \frac{\$787}{\$2.50 - \$.79}$$

If labor is available on the farm at no cash or opportunity cost, annual cash combine costs would be reduced by $.35 in the above example and breakeven acres would be 334.

Combine Strategies for Alternative Timeliness Preference

Heavy emphasis is frequently placed on harvesting wheat as soon as it ripens. Such emphasis may be expressed quantitatively as the number of days a farmer will normally allow for the combining operation. The level of the restrictions for an individual farmer reflects (1) his subjectively expected or calculated grain damage or yield loss for different lengths of harvest seasons, and (2) a set of conditions relating to transportation and marketing facilities, varieties of grain produced, the nature and location of farming tracts, other farming operations, number of acres to be cut, and the operator's psychological characteristics and economic environment. Long-run Panhandle weather records for the usual combining period of June 20-June 30 indicate that the full 11 days have been "suitable" for combining 30 percent of the time and 10, 8, 7, and 3 days were suitable 50, 75, 90, and 100 percent of the time. Eight scattered hail

[1] See Appendix for an explanation of procedures for "breakeven" analysis.

Table VI.—Least Cost Machinery Combinations and Ranges in Total Per Acre Costs for Selected Probabilities of Workday Numbers and $1/Hr. Labor

Number and Probability of Workdays Available[1]		Least Cost Machinery Combinations	Approximate Range of Cropland Acres	Range of Total Preharvest Cost per Acre	Range of Annual Tractor Use
				($/A.)	(Hrs/Yr/Tractor)
P = .04	The number of workdays, July 1 - July 15 ≧ 15	Custom	0-300	5.10	-
		1-3 plow	300-400	5.18-4.52	340-460
		1-4 plow	400-900	4.54-3.23	350-800
		1-5 plow	900-1600	3.23-2.77	710-1250[2]
		2-4 plow	1600-2000	3.13-2.92	680-740
P = .5	The number of workdays, July 1 - July 15 ≧ 13	Custom	0-300	5.10	-
		1-3 plow	300-400	5.18-4.52	340-460
		1-4 plow	400-900	4.54-3.23	350-800
		1-5 plow	900-1400	3.23-2.82	710-1100
		2-4 plow	1400-2000	3.28-3.92	590-740
P = .75	The number of workdays,	Custom	0-300	5.10	-
		1-3 plow	300-400	5.18-4.52	340-460

	≧ 11	1-5 plow	900-1200	3.23-2.94	710-940
and	———	2-4 plow	1200-1700	3.48-3.07	500-630
P = .75	The number of workdays, May 25 - June 10 ≧ 14 ———				
P = .9	The number	Custom	0-300	5.10	·
	of workdays,	1-3 plow	300-400	5.18-4.52	340-460
	July 1 - July 15	1-4 plow	400-800	4.54-3.36	350-710
	≧ 8	1-5 plow	800-850	3.37-3.30	630-670
and	———	2-4 plow	850-1300	3.94-3.37	360-550
P = .9	The number of workdays, May 25 - June 10 ≧ 9 ———				

[1] Number of workdays available may be considered "expected days" or as reflections of willingness to accept the indicated probabilities of getting work completed with a given set of machinery.

[2] At the upper level of use, the tractor is worn out in less than ten years. Thus, tractor costs are at the lowest level possible.

Table VIII.—Total Costs Per Acre for Twelve, Fourteen, and Sixteen Foot Self-Propelled Combines for Selected Numbers of Days of Use Per Year

Number of Days Used per Year	12 Ft. Combine $/A	12 Ft. Combine Annual Acres[1]	14 Ft. Combine $/A	14 Ft. Combine Annual Acres[1]	16 Ft. Combine $/A	16 Ft. Combine Annual Acres[1]	Custom Combine $/A
1	19.09	43	18.40	49	18.42	58	3.00
2	9.94	86	9.57	98	9.56	116	3.00
3	6.38	129	6.63	147	6.61	174	3.00
4	5.36	172	5.16	196	5.13	232	3.00
5	4.45	215	4.28	245	4.24	290	3.00
6	3.84	258	3.69	294	3.65	348	3.00
7	3.40	301	3.27	343	3.23	407	3.00
8	3.03	344	2.96	392	2.91	464	3.00
9	2.82	337	2.71	441	2.66	522	3.00
10	2.62	430	2.52	490	2.47	580	3.00
12	2.31	518	2.22	588	2.18	696	3.00
14	2.10	602	2.01	686	1.96	812	3.00
16	1.93	638	1.85	784	1.81	928	3.00
13	1.81	774	1.73	882	1.68	1044	3.00
20	1.70	860	1.63	980	1.59	1160	3.00
22	1.62	946	1.55	1078	1.50	1276	3.00
24	1.55	1032	1.43	1176	1.44	1392	3.00

[1] Performance rate data provided by farmers and used here are as follows:

Combine Size	Acres/Day
12 ft.	43
14 ft.	49
16 ft.	58

storms of varying severity were reported during June in 30 years of weather analyzed. Five of the hail storms were in the June 20—June 30 period.

Table VIII shows combine costs per harvested acre for varying days of expected use. It is designed for use of farmers and custom operators having specific restrictions on combining days. For example, if a custom operator normally tours from Southern Oklahoma to Central Kansas during a ripening season of one month, and work is available, the number of days suitable for combining is a major restriction on income. According to Table VIII, a custom operator expecting, say, 24 actual work days and a rate of $2.50 per acre could choose 16-foot machines rather than 14 foot to cut more acres at a lower cost and secure approximately $276 additional returns per machine.

Strategies for farmers with varying acre and day restrictions may also be devised from data in Table VII and Table VIII. If custom operators are available and farmer or hired labor is $1.50 per hour,

Table IX.—Per-Acre and "Insurance" Costs of Alternative Combine Strategies[1]

Strategy	500 Acres[2] Combining Plan[3]	500 Acres[2] Average Cost/Acre[4]	500 Acres[2] Insurance Cost[5]	2000 Acres[2] Combining Plan	2000 Acres[2] Average Cost/Acre[4]	2000 Acres[2] Insurance Cost
		($)	($/A)		($)	($/A)
A	Custom	3.00	.64	Custom	3.00	1.27
B	Custom-210 A @ $3.00 & 1-16'—290 A @ $4.24	3.71	1.35	Custom—1710 A @ $3.00/A & 1-16'-290 A @ 4.24	3.18	1.45
C	(1) 1-12'	2.36	--			
	(2) 1-14'	2.48	.12			
	(3) 1-16'	2.76	.40	2-16'	1.73	--
D	1-16'	2.76	.40	4-16'-500 A per machine	2.76	1.03
E	1-12'	2.36	--	(1) 3-14'	2.05	.32
				(2) 3-16'	2.24	.51

[1] Combine strategies considered are as follows:

A. Hire a custom operator; assume that combines will be available.

B. Hire a custom operator; own one combine which is used an average of five 10-hr. days per year.

C. Own combines sufficient for harvesting wheat in 11 days and sorghum in an unlimited period. Costs of additional flexibility from using larger machines are shown in (1), (2), and (3).

D. Own combines sufficient for harvesting wheat in 5 days.

E. Own combines sufficient for harvesting wheat in 8 days.

[2] Wheat is roughly 60% of total acres to be combined.

[3] As a practical matter, combine plans achieve the desired conditions within a close range rather than exactly. Similarly, mixed sizes of machines are not shown for simplicity of exposition.

[4] Costs for mixed strategies are weighed averages based on acres combined.

[5] The "insurance" cost is defined here as the additional cost of other alternatives above the least cost, though perhaps most risky, alternative, in terms of crop-loss hazard. Risks associated with custom hiring depend on availability of custom operators. However, a comparable risk from dependence on owned machines may result from breakdown hazards.

custom hiring provides lower costs for day restrictions of slightly less than eight. Farmers doing all of their own combining would choose at least one larger machine. Other strategies involving use of custom and owned machines and placing emphasis on timing of wheat harvest require more complicated examples. Table IX provides estimates of per acre and "insurance" costs for plausible farmer strategies.

A farmer having little confidence in availability of custom combines and placing fairly strong emphasis on avoiding grain damage or loss might use strategy D. For his timeliness preferences, he would pay an additional $.40 to $1.03 per acre over the range of acres included in Table IX. However, his lack of confidence in custom availability would not add to costs. Strategy E reduces emphasis on timing with a consequential saving in costs. A farmer using strategy A would have strong confidence in ability to hire machines and could avoid crop damage or loss risks by completing harvest as rapidly as conditions other than field-harvest capacity allow. He would pay $.64 to $1.27 for the timeliness advantage. Strategy C requires acceptance of maximum weather hazards for a saving of $.40 to $1.45 per acre. Finally, B provides a hedge against shortages in custom combines *and* weather hazards and costs more than all other strategies.

Summary

Machinery sets with different sizes of tractors have almost equal costs over a wide range of cropland acres. Thus, size of tractor decisions do not appear particularly critical. Even when a very low or very high charge is made for labor, cost differences for alternative one-tractor sets are relatively small. Thus, labor prices have little influence on choice of a tractor size. In general, a 5-plow tractor and equipment will allow relatively low costs per acre over common sizes of commercial farms and provide for timely completion of jobs considered critical by farmers.

Numbers of tractors and use of custom rather than owned machinery may have substantial effects on total machinery costs. If machines are available when needed, custom hiring will reduce costs on farms up to 300 acres.

A machinery plan involving purchase and maintenance of two (rather than one) tractors and related equipment would add about $600 to annual machinery costs on farms with 600 to 1,000 cropland acres. Jobs considered critical by farmers can be handled by one rather than two tractor sets on farms of that size. Other jobs such as second, third, and fourth onewaying of wheat land, harrowing sorghum and second cultivation of sorghum are done during July 15-September 5.

Appropriate timing of the latter practices does not appear to be limited for the least-cost machinery sets.

Fixed days for completing the combining operation or willingness to pay additional costs for a larger machine as "timeliness insurance" provide an incentive to buy large combines. Large machines provide lower cost services when days to combine are fixed. Smaller machines allow lower per acre costs when a restriction is not placed on harvest days. However, subtitution of a 14 ft. for a 12 ft., or a 16 ft. for a 12 ft. on 300 to 1,000 acre jobs only requires annual "insurance" costs of $40 to $70, and $150 to $190, respectively. Breakeven acreages for custom rates of $3.00 per acre are approximately 360, 385, and 445 acres for the 12-, 14-, and 16-foot machines.

Appendix

Major data providing a basis for this study are presented in Appendix Tables I thru VII. As an aid to interpretation and use of data presented, cost components for farm machinery are identified and briefly discussed.

Fixed Costs

Depreciation, interest, taxes and insurance are conventionally classified as components of machinery fixed costs. The term "fixed" does not necessarily mean "inescapable" because machinery can be "junked" or sold to shift or end a portion of ownership expenses, if such a change is profitable. Fixed costs are those expenses which do not vary with amount of use once the initial investment is made and as long as ownership continues. For example, interest must be paid on the investment whether the machine is used at capacity or allowed to set idle. Clearly, fixed costs **per unit of use** decrease as machine use increases. Thus, levels of fixed costs and amount of use are major sources of cost economies or diseconomies.

Depreciation

Depreciation costs for machines in the study were calculated as follows:

$$\frac{\text{(Initial cost of machine)} - \text{(Salvage value in expected year of disposal)}}{\text{The expected age at which the machine will be traded}}$$

Appendix Table I indicates ages at which machines are normally traded, as reported by Oklahoma Panhandle farmers. The implied "years of useful life" reflect (1) amounts of use, (2) conditions of use, (3) preferences of farmers, (4) managerial practices, (5) effects of technological improvement in machinery, (6) storage and maintenance practices, and (7) total use capacities of different machines. Thus, individual farmers may have a wide range of trade-in practices. Salvage values equal to 20 percent of purchase prices were used in the study because of relatively low trade-in ages and high actual salvage values reported by farmers and dealers. Effects of bargaining on salvage values were excluded. Constant amounts of annual depreciation (straight line depreciation) were used since trade-in and purchase practices were assumed fixed and known.

Interest

An interest charge of six percent on the average value of a machine over its life on the farm was used in the study. That is:

$$\text{Interest Cost} = \left(\frac{\text{Purchase Price} + \text{Salvage Value}}{2}\right) \times 6 \text{ Percent}$$

Money invested in machinery reduces cash or credit available for other investments. Thus, interest is a cost whether the farmer or a credit agency furnishes the capital.

Taxes

Farm machinery is taxed as personal property on the basis of its assessed valuation. Tax rates used in this study were $37 per $1,000 assessed valuation. Assessment values were obtained from the 1960 Tax Assessment Schedule prepared by the Oklahoma Tax Commission.

Insurance

Insurance costs were included in fixed costs for expensive items subject to important fire or other damage. Insurance charges were .4 percent of the machine purchase price. The rate is approximately $8 per $1,000 of value over the life of the machine. Insurance is logically included as a fixed cost whether a formal insurance contract is made or the farmer assumes the risk and pays losses over time.

Variable Costs

Variable or *operating costs* include fuel, repairs, labor, lubrication and expendible items such as wire, twine, and discs. Unlike fixed costs, operating costs are not incurred unless machines are actually used. In this study, variable costs per acre or hour are assumed constant over all ranges considered. Total variable costs for machines studied are presented in Appendix Table VI. Other appendix tables provide data necessary for cost computations.

Repairs

Estimates of repair costs reported in Appendix Table VI were obtained from Oklahoma Panhandle farmers and machinery dealers. In some cases, basic costs obtained from these sources were assumed to apply to modal equipment and modal use. Then, costs for other sizes were estimated from the modal equipment costs, adjusted for differences in new prices of equipment. Repair data in Appendix Table V might also be used for analysis of alternative trade-in practices.

Labor

A labor charge is not included in Appendix Table VI. Labor requirements per work unit are included in Appendix Table IV and may be used to compute a labor cost as appropriate.

Fuel and Lubrication

Fuel requirements for power equipment of various sizes are presented in Appendix Table III. Prices of fuel used in the study are in Appendix Table II. Lubrication charges were estimated as percentages of new machine costs.

Cost Data and Comparisons for Selected Types of Tractors

Cost data presented to this point apply to butane (L.P.) tractors. L. P. tractor costs per hour of use appear lower than those for diesel and gasoline tractors of comparable sizes, given the combinations of new tractor prices, fuel prices, fuel use levels and nonfuel variable costs used in this study. Costs per hour for a given tractor cannot be lower over *all* ranges of use unless annual fixed costs *and* variable costs per hour are lower than those for other tractors of the same size. For example, Row 2 and Row 5, Appendix Table VIII indicate that: (1) annual fixed costs for a 4-plow diesel tractor exceed annual fixed costs for a 4-plow L.P. by $40 ($530-430), assuming that the diesel tractor purchase price is $300 greater; and (2) variable costs per hour are 15¢ higher ($1.05—$.94) for the diesel. Thus, the 4-plow L.P. tractor has lower costs per hour of use and the difference between total costs per hour widens as hours of use increase.

The range over which gasoline tractors have lower total costs compared to L.P. or diesel per hour can be obtained by use of equations presented in Appendix Table VIII. For example:

(1) A.C./hour for a 4-plow L.P. = $A.C._{4L.P.} = \frac{490}{Hr.} + .90$,

(2) A.C./hour for a 4-plow gas = $A.C._{4\,G} = \frac{450}{Hr.} + 1.48$, and

(3) at the breakeven hours, $A.C._{4\ L.P.} = A.C._{4\ G}$

Thus, (4) $\frac{490}{Hr.} + .90 = \frac{450}{Hr.} + 1.48$, and

(5) Breakeven hours $= \frac{\$490 - \$450}{\$1.48 - 90¢} = \frac{\$40}{58¢} = 69.$

That is, at 69 hours, costs of the 4-plow L.P. and 4-plow gasoline are equal, above 69 hours L.P. costs are lower. Differences in gasoline and L.P. variable costs are primarily attributable to the reported \$.13 per gallon cost advantage of L.P. fuel. Thus, as the price difference decreases, breakeven hours increase.

Differences in diesel and L.P. variable costs are attributable to assumed higher repair costs for diesel and, to some extent, lower fuel costs for L.P. However, diesel tractor prices are higher than those for L.P. tractors. Thus, variable costs for diesel tractors must be lower than those of L.P. tractors if diesel is to offer a cost advantage at any level of annual use. Such a condition would require a substantial reduction in variable costs reported for diesel or an increase in L.P. variable costs. Because of the size of cost changes required, results reported in Appendix Table VIII appear fairly stable for the Oklahoma Panhandle. At high levels of annual use, differences in total costs per hour approach differences in variable costs per hour. For example, 700 hours annual use for a 4-plow diesel and L.P. tractor gives annual costs of $\frac{530}{700} + 1.05 = 1.81$ and $\frac{490}{700} + .90 = 1.60$, respectively. Thus, farmers' preferences for dealers, types of equipment, fuel or other nonquantifiable conditions may in some cases offset the relatively small \$147 difference in total annual machinery cost.

Appendix Table I.—Estimated Length of Life, Average Annual Use, and Reasons for Trading, Oklahoma Panhandle Machinery Survey, 1960

Item	No. Reported	Average Annual Use	Estimated Life	Reasons for Trading First	Reasons for Trading Second
		(Hrs.)	(Yrs.)		
Tractor, Total	113	--	10[1]	High Maint. Cost	Get Imprvd. Model
(5-plow)	5	356			
(4-plow)	58	243			
(3-plow)	35	296			
(2-plow)	15	164			
Combine	39	--	8.5[1]	High Maint. Cost	Get Imprvd. Model
12 Ft.	8	84			
14 Ft.	23	102			
16 Ft.	8	117			
Oneway	80	--	12[1]	High Maint. Cost	Get Imprvd. Model
9-10 Ft.	5	106			
12-13 Ft.	14	163			
15-16 Ft.	52	167			
17-18 Ft.	9	228			
Chisel	45	60[2]	16[1]	High Maint. Cost	Get Imprvd. Model
12-13 Ft.	17				
14 Ft.	3				
15-16 Ft.	20				
17-18 Ft.	5				
Drill 16-10	103	56	10	Get Imprvd. Model	High Maint. Cost
Lister	39	86	15		
Cultivator	25	33	18		
Pickup	58	16,000	5.4	High Maint. Cost	Get Imprvd. Model
Auto	--	--	3.7	Get New Model	High Maint. Cost
2 Ton Truck	54	7,500	10	High Maint. Cost	Get Imprvd. Model

[1] Average expected years life reported for all sizes of equipment.

[2] Average annual use reported. Chisels and oneways are used as substitutes in land preparation, depending on weather and soil conditions. For simplicity, the oneway operation is referred to in this publication rather than various combinations of one-waying and chiseling.

Appendix Table II.—Cost Assumptions[1]

Item	Unit	Price
Gasoline	gal.	$ .215
Diesel Fuel	gal.	.143
Butane (L.P.)	gal.	.081
Motor Oil	gal.	1.04
Tractors		
5 Plow L.P.	ea.	4440.
5 Plow Diesel	ea.	4775.
4 Plow Gas	ea.	3610.
4 Plow L.P.	ea.	3910.
4 Plow Diesel	ea.	4200.
3 Plow Gas	ea	2840.
3 Plow L.P.	ea.	3490.
3 Plow Diesel	ea.	3760.
Combines, S.P.		
16 Ft.	ea.	7380.
14 Ft.	ea.	6240.
12 Ft.	eo.	5720.
Oneways		
15-16 Ft.	ea.	1160.
12-13 Ft.	ea.	1050.
Chisel		
15 Ft.	ea.	970.
12 Ft.	ea.	600.
Drill (16-10)	ea.	850.
Lister		
4 Row	ea.	690.
2 Row	ea.	335.
Cultivator		
4 Row	ea.	490.
2 Row	ea.	315.
Harrow (4 Section)	ea.	200.
Trucks		
1/2 T. Pickup	ea.	2050.
2 T. Truck	ea.	4550.

[1] Approximate 1960 actual transaction prices reported by Oklahoma Panhandle farmers and machinery dealers.

Appendix Table III.—Fuel Requirement Estimates, Oklahoma Panhandle Machinery Survey, 1960

	Average Use	Standard Deviation of farmer's estimates
	(Gallons/Hour)	
I. FUEL USE:		
A. Combines:		
1. 12 foot	3.56	
2. 14 foot	4.44	
3. 16 foot	4.90	
B. Tractors—Heavy Load		
1. 5 plow diesel	4.0	0
2. 5 plow butane	6.7	1.23
3. 4 plow diesel	2.8	0.19
4. 4 plow butane	5.3	0.26
5. 4 plow gasoline	4.5	0.50
6. 3 plow diesel	2.5	0.76
7. 3 plow butane	4.7	0.43
8. 3 plow gasoline	3.7	0.35
C. Tractors—Light Load		
1. 5 plow diesel	3.0	0
2. 5 plow butane	4.8	1.10
3. 4 plow diesel	2.1	0.15
4. 4 plow butane	4.0	0.20
5. 4 plow gasoline	3.3	0.84
6. 3 plow diesel	1.9	0.90
7. 3 plow butane	3.6	0.43
8. 3 plow gasoline	2.9	0.36
D. Trucks (miles/gallon)		
1. 1/2 ton pickup	13.16	0.10
2. 2 ton truck	8.46	0.10

Appendix Table IV.—Machine Performance Rates and Standard Deviations

Machine[1]	Acres/ Hour	Standard Deviation
I. Chisels:		
15-16 ft. (4-5 plow)	6.1	1.02[2]
15-16 ft. (4 plow)	5.1	1.02
12-13 ft. (3 plow)	4.4	0.19
II. Combines		
16 ft.	5.8	0.68
14 ft.	4.9	0.21
12 ft.	4.3	0.44
III. Cultivators:		
4 Row (4 or 5 plow)	6.4	0.44
2 Row (3 plow)	3.1	.. ..
IV. Drills:		
16-10 (3,4 or 5 plow)	5.4	0.19
V. Harrow:		
4 Section (4-5 plow)	10.3	0.50[2]
4 Section (3-4 plow)	8.6	0.50
VI. Listers:		
4 row blank (4-5 plow)	6.4	0.52[2]
4 row blank (4 plow)	5.3	0.52
2 row blank (3 plow)	4.0	
4 row plant (4-5 plow)	4.6	0.52
2 row plant (3 plow)	3.3	
VII. Oneways:		
15-16 ft. (4-5 plow)	6.2	1.17[2]
15-16 ft. (4 plow)	5.2	1.17
12-13 ft. (3 plow)	4.3	0.35

[1] Plow rating in parentheses is the tractor size used for the respective performance rate.

[2] Standard deviation for the 5-plow tractor is assumed to be the same as that calculated for the 4-plow tractor.

Appendix Table V.—Estimated Costs and Frequencies of Selected Repair & Maintenance Jobs

Machine	Job	Approximate Total Cost	Frequency (Yrs.)	Description
Combine	Engine Overhaul	$162.00	5	Major engine overhaul
	Sickle	30.00	1.5	Replace sickle
	Belts	60.00	2.8	Replace belts
	Guards	10.00	1	Replace sickle bar guards
	Bearings	20.00	1	Replace worn bearings
	Clyinder bar	61.00	2.5	Replace cylinder bar
	Concaves	8.00	1	Replace concaves
	Pitman	10.00	1	Repair Pitman rod
	Reel slats	10.00	1	Replace broken slats
Tractor	Engine Overhaul	216.00	4.6	Major engine overhaul
(Butane)	Tune up	14.00	1	Engine tune up (parts & labor)
	Rear tires	310.00	3.8	Replace rear tires
	Front tires	40.00	6	Replace front times
	Rings & valves	138.00	5	Replace rings & grind valves
	Battery	31.00	2	Install new battery
	Pump	20.00	4	Calibrate pumps
Oneway	Discs	82.00	3.6	Replace discs
	Discs	19.00	1.4	Sharpen discs
	Bearings	23.00	5.25	Replace bearings
	Tires	12.00	3.5	Replace tires
Chisel	Replace chisels	19.00	2	Install new chisels
Lister	Bottoms	49.00	3	Replace bottoms
	Points	26.00	2	Replace points
	Misc.	12.00	3	Miscellaneous maintenance
Drill	Discs	28.00	4	Replace discs
	Misc.	17.00	1	Miscellaneous maintenance

Appendix Table VI.—Fixed, Variable Costs and Total Cost, Excluding Labor, of Owning Individual Items of Machinery.

	Fixed Costs/Year					Variable Costs[1]					
Machine	Depreciation	Interest	Taxes	Insurance	TOTAL	Repairs	Fuel	Lube	Oil	Oil Filters	TOTAL
Chisels											
15 foot	49.22	34.78	5.29	--	89.29	.0471	----	.0095	----	----	.0566
12 foot	30.57	21.60	3.15	--	55.32	.0341	----	.0068	----	----	.0409
Combines											
12 foot	538.73	206.06	28.71	13.74	787.24	.2324	.1780	.0133	.0086	.0051	.4374
14 foot	587.67	224.78	38.05	14.99	865.49	.2224	.1948	.0127	.0076	.0045	.4420
16 foot	694.21	265.63	50.32	17.70	1027.86	.2220	.1816	.0127	.0084	.0099	.4346
Cultivators											
4 row	21.43	17.74	2.96	--	42.13	.1234	----	.0070	----	----	.1304
2 row	13.70	11.34	1.79	--	26.83	.1234[2]	----	.0070[2]	----	----	.1304[2]
Drill 16-10	71.75	30.67	6.01	--	108.43	.1630	----	.0391	----	----	.2021
Harrow											
4 sec.	9.98	7.27	1.22	--	18.47	.0023	----	.0002	----	----	.0025
Listers											
4 row	37.55	24.84	3.70	--	66.09	.1358	----	.0070	----	----	.1428
2 row	12.06	18.23	1.82	--	32.11	.1358[2]	----	.0070[2]	----	----	.1428[2]
Oneways											
15 foot	80.14	41.83	6.35	--	128.32	.0865	----	.0098	----	----	.0963
12 foot	72.41	37.80	5.42	--	115.63	.0953	----	.0107	----	----	.1060
Butane Tractors (heavy work)											
5 plow	350.29	159.84	39.59	10.65	560.37	.432	.543	.062	.029	.013	1.079
4 plow	308.24	140.65	31.56	9.38	489.83	.381	.429	.048	.027	.012	.897
3 plow	275.50	125.71	21.57	8.38	431.16	.340	.381	.047	.020	.006	.794

Butane Tractors (light work)											
5 plow	350.29	159.84	39.59	10.65	560.37	.432	.389	.062	.029	.013	.925
4 plow	308.24	140.65	31.56	9.38	489.83	.381	.324	.048	.027	.012	.792
3 plow	275.50	125.71	21.57	8.38	431.16	.340	.292	.047	.020	.006	.705
Trucks[1]											
Pickup	303.70	73.80	13.20	26.88	417.53	.0065	.0224	.0009	.001	.0013	.0321
2 ton	367.68	163.80	29.69	35.00	596.17	.0302	.0349	.0042	.0013	.0014	.0720

[1] Units for variable costs are as follows:
tractors — variable cost per hour,
trucks — variable cost per mile,
other machinery — variable cost per acre.

[2] Cost data on 2-row cultivator and 2-row lister were not available from the survey. Consequently, it was assumed that the variable cost per acre would be the same as for 4-row equipment. Cost computations for these two items of machinery were based on this assumption.

Appendix Table VII.—Maintenance and Fuel Storage Equipment

1. Average investment in maintenance equipment in Panhandle __$270
2. Additional investment in maintenance equipment per year____$ 50
3. Number of Fuel Storage Tanks Reported by Farmers—

	Kind of Tank			
Size (Gallons)	Gasoline	Butane	Diesel	Total
Less than 300	6	3	2	11
300 to 600	23	21	9	53
Over 600	1	3	1	5
Total	30	27	12	69

4. Estimated cost of fuel storage tanks:
   A. L.P. tanks:
      250 gallon — $195
      500 gallon — $315
   B. Gasoline tanks:
      275 gallon — $ 80
      550 gallon — $125

Appendix Table VIII.—Estimated Total Cost Per Hour Equations For Selected Types and Sizes of Farm Tractors

	Fuel	Size	Average Total Cost/Acre	
			Heavy Load $/hr.	Light Load $/hr.
1.	Diesel	5 plow (42-50 D.B.H.P.)	$AC = \frac{600^{1}}{Hr.^{3}} + 1.31^{2}$	$AC = \frac{600}{Hr.} + 1.16$
2.	Diesel	4 plow (32-42 D.B.H.P.)	$AC = \frac{530}{Hr.} + 1.05$	$AC = \frac{530}{Hr.} + .95$
3.	Diesel	3 plow (24-32 D.B.H.P.)	$AC = \frac{470}{Hr.} + .94$	$AC = \frac{470}{Hr.} + .85$
4.	Butane (L.P.)	5 plow (42-50 D.B.H.P.)	$AC = \frac{560}{Hr.} + 1.08$	$AC = \frac{560}{Hr.} + .92$
5.	Butane (L.P.)	4 plow (32-42 D.B.H.P.)	$AC = \frac{490}{Hr.} + .90$	$AC = \frac{490}{Hr.} + .79$
6.	Butane (L.P.)	3 plow (24-32 D.B.H.P.)	$AC = \frac{430}{Hr.} + .79$	$AC = \frac{430}{Hr.} + .70$
7.	Gasoline	4 plow (32-42 D.B.H.P.)	$AC = \frac{450}{Hr.} + 1.48$	$AC = \frac{450}{Hr.} + 1.22$
8.	Gasoline	3 plow (24-32 D.B.H.P.)	$AC = \frac{350}{Hr.} + 1.20$	$AC = \frac{350}{Hr.} + 1.03$
9.	Gasoline	2 plow (less than 24 D.B.H.P.)	$AC = \frac{330}{Hr.} + 1.05$	$AC = \frac{330}{Hr.} + .95$

[1] For each equation, the figure in this position is the approximate annual fixed cost (depreciation, interest, taxes and insurance) per year.

[2] For each equation, the figure in this position is the estimated variable cost per hour of use excluding labor costs (i.e., costs of fuel, oil, and repair). A charge for labor is not needed for tractors having equal time requirements (e.g., tractors of equal sizes). Comparisons between tractors of different sizes may be made by using performance data presented in earlier tables and an appropriate wage rate.

[3] Hr. refers to hours the tractor is used per year. The range of Hr. over which the equations apply is total hours useful life divided by the number of years the machine is normally kept. For commercial farms in the Oklahoma Panhandle, job timeliness restrictions effectively prevent farmers from reaching the upper limit of maximum hours per year.

Oklahoma's Wealth in Agriculture

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than $700,000,000 annually. The value added by manufacturers of farm products adds another $130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.

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