Cost Analysis of Dryland Farm Machinery in Latah, Power, and Bannock Counties of Idaho

by

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PREFACE

This study estimated the unit cost of operating dryland farm machinery in Latah, Power, and Bannock Counties of Idaho. Information was obtained from 48 dryland farmers. The information received included purchase prices, hours of annual use, age, fuel cost, oil cost, repair and maintenance, and labor cost. The fixed cost estimates were derived from equations in the American Society of Agricultural Engineers' yearbook. Two depreciation methods were used: Straight Line depreciation and Sum-of-the-Years'-Digits depreciation.

The objectives included the cost estimation of various sizes of farm power units, to develop Long-Run Planning Curves, and to aid the farmer in replacement decisions of dryland farm machinery. Two methods were used to achieve these objectives.

One method utilizes a Standardized Computer Program that estimated total cost-per-hour values for individual machines. Total cost-per-hour curves were produced for various dryland farm machinery. The total cost-per-hour curves were grouped in accordance with the Straight Line depreciation method and the Sum-of-the-Years'-Digits depreciation method.

Replacement decisions were based on the machine's economic life.

The machine's economic life ends when the minimum total cost-per-hour point is reached. At this point, the curves indicate that replacement should be considered but other factors such as income tax, investment credit, and inflation influence the replacement decision.

The second cost-estimating method utilized regression analysis to develop Long-Run Planning Curves for the three counties. The Long-Run Planning Curves showed the cost per hour and cost per acre of various farm sizes. The Long-Run Planning Curves were developed by fitting a mathematical function to the data received from the farmers. The analysis of the Long-Run Planning Curves indicated that economies of size existed. Power County showed the greatest degree of economies of size.

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INTRODUCTION

Agriculture is the primary industry in Idaho and plays a major role in the State's economy. The largest single expenditure on many Idaho farms is the cost of owning and operating farm machinery. With today's rising cost of fuel, oil, and equipment, it is necessary that the modern farmer make accurate and timely decisions concerning the management of his machinery. Machinery management becomes increasingly complicated by continuous engineering advances. Unit cost information is needed to allow the farmer to invest his money at the proper time and place to minimize his cost of operation. Since 1968, the price of machinery has increased by approximately 33 percent, according to the U.S. Bureau of Labor Statistics with the base year, 1967 [9]. This is due mainly to the inflationary trend of the U.S. economy, aggravated by the energy crisis.

Stated specifically, the problem is the rising cost of owning and operating farm machinery. In this study, information was provided concerning the cost of operating various sizes of dryland farm power units so guidelines could be established to aid farmers in managerial decisions. Managerial decisions cannot be made without an understanding of the factors that influence machinery operating cost. For this reason, a study was undertaken to provide information that would allow farmers to minimize their operating cost.

Study Area

The data for this study were collected in the spring of 1975 from Latah, Power, and Bannock Counties in Idaho. Forty-eight farmers from two different areas of the State were interviewed on the cost of owning and operating farm machinery in dryland farming enterprises. Information obtained was for the 1974 production year. The farmers were selected in each county from a list of dryland farmers obtained from the county agents. The farmers were contacted by phone to arrange the interviews.

In Latah County, the farms included in the sample ranged in size from 263 to 4,000 acres with the average being 1,116 acres. The farmland consists of rolling hills surrounded by mountains. The major crops are wheat and barley. The average yield is 55 bushels of wheat per acre and 52 bushels of barley per acre. The soils are the Loess types with a high susceptability to erosion. Precipitation is approximately 24 inches a year, allowing extensive use of fertilizer. Continual cropping is the general practice.

Power and Bannock Counties are located in the southeastern portion of the State. These counties were chosen because they encompass one of the largest dryland farming areas in the State. Most of the data were collected in the Rockland Valley, Arbon Valley, and the Downey-Arimo regions of the counties. The farms in the sample in these counties ranged in size from 180 to 5,000 acres. The average farm size was 1,826 acres. This area receives approximately 10 inches of annual rainfall; thus small amounts of fertilizer are used and summer fallow is a general practice. Fertilizers were used sparingly because of the lack of moisture. In 1974, the crops in the sample were extremely poor. The average yields for Power and Bannock Counties were 17 bushels of wheat and 25 bushels of barley per acre.

Data

Forty-eight farmers in the three counties were personally interviewed utilizing a questionnaire concerning the cost of operating dryland farm machinery. The farmers estimated their 1974 operating costs and hours of use for each machine.

Individual machinery information included the purchase price, age, number of annual hours used, horsepower of the machine, field capacity, type of fuel, width of the machine and length of haul. Averages of purchase price, hourly use, and age were utilized in a computer program (see Table 1).

It was not possible to break down the operating costs for each type of implement into the following components such as oil cost, fuel cost, labor cost, grease cost, repairs, and maintenance costs.

Objectives

The major objectives of the study are:

1. To estimate the cost of operating various sizes of dryland farm machinery.
2. To develop functional relationships between total cost of machinery and the size of the farm operations.
3. To establish guidelines for ideal replacement scheduling of farm machinery.

Table 1.

Agricultural Machinery Used in Dryland Farming

Information Obtained from Farmers
in Latah, Power, and Bannock Counties

Size	Average P.T.O. H.P.	No. in each group	Average purchase price	Average annual hours of use	Average age
Tractors					
20-70 D.B.H.P.	63	51	$ 4,319	250	15
71-144	149	58	10,882	580	13
145-225	257	31	20,275	579	4
Combines					
12-16 ft.		38	14,467	190	10
18-20		40	19,075	246	6
Mold Board Plow		38	954	87	12
Chisel Plow		30	1,991	156	6
Disc Plow		21	2,483	108	9
Disc		69	2,028	73	8
Rodweeder		59	1,913	109	10
Cultivator		22	1,588	55	8
Rotovator		2	3,000	50	4
Fertilizer Spreader		6	887	38	8
Sprayer		16	272	19	5
Harrows		10	629	68	11
Packers		10	623	27	15
Trucks		108	5,535		10
Grain Drill, Tandem					
10-32 ft.		45	2,661	95	9
33-72		19	4,087	92	8

Procedure

Machinery operating costs usually are classified in two groups, namely, variable and fixed costs. Variable costs vary with use. Total variable costs are maintenance and repairs, fuel, oil, grease, and labor. Fuel cost was comprised of gasoline and diesel cost. The oil and grease costs consist of motor oil, hydraulic oil, and lubrication grease. The labor cost consists of all wages paid by the farmer for work performed on the farm and on the farm machinery. Repairs and maintenance was one of the largest costs on the farms in Latah, Power and Bannock Counties. The repair and maintenance cost was composed of all machinery parts necessary to keep the machinery operable. Total fixed costs do not vary with use of the machine and include taxes, shelter, insurance, interest, and depreciation. Depreciation is the loss in value of a machine due to wear and tear and to some degree obsolescence.

The first objective was achieved by computing annual operating costs utilizing a computer program model received from Peterson [7], and modified by Peterson and the author to achieve the objectives of this study. The computer program utilizes a series of formulae from the Agricultural Machinery Management Data, A.S.A.E. Data: A.S.A.E. D 230.2 [1]. The program plots an average total cost curve for the various types of dryland farm equipment. Total cost-per-hour curves were developed by plotting total cost per hour against total hours of annual use. The total cost-per-hour curves were classified by the two methods of depreciation. In estimating depreciation, two methods were used: 1) The Straight Line method, and 2) Sum-of-the-Years'-

Digits method. These depreciation methods were chosen to demonstrate the cost difference between a constant depreciation cost and an accelerated depreciation cost.

The Straight Line method is equal to the new price less salvage value divided by estimated useful life. The salvage value was set to be 10 percent of the purchase price. This method allocates an equal depreciation cost for every year the machine is used [6].

Equation 1.

$$\text{Depreciation} = \frac{\text{New price minus Salvage Value}}{\text{Estimated Useful Life}}$$

The Sum-of-the-Years'-Digits method allocates a larger portion of the cost to the early years of a machine's life. Sum-of-the-Years'-Digits depreciation continually decreases from the first to the last year of a machine's life. The depreciation rate is a fraction, of which the numerator is the remaining years of useful life times price and the denominator is the sum of the years of useful life [6]. This method more closely follows the true value change.

Equation 2.

$$\text{Depreciation} = \frac{\text{Remaining Years times Price}}{\text{Sum of the Years}}$$

Values for estimated life were taken from the A.S.A.E. [1]. The estimated life values were determined by dividing hours of estimated wear-out life by the average hours of annual use for each group. The estimated wear-out life figures are in Appendix Table 1.

Equation 3.

$$\text{Expected Life of Machine} = \frac{\text{Hours of wear-out life}}{\text{Hours of annual use}}$$

Interest is a real ownership cost, even though the farmer may not borrow to buy the machinery. The first year, eight percent interest of the average purchase price was charged. Every year thereafter it was charged on the remaining value of the machinery.

Equation 4.

Interest Charge = (.08) (Remaining Value of Machine)

Property taxes are costs that are incurred regardless of the use of the machine. Two percent of the remaining value of the machine was used to derive a figure for taxes and licenses. The two percent value was taken directly from the A.S.A.E. [1].

Equation 5.

Property Taxes = (.02) (Remaining Value of Machine)

Insurance is a necessity because of the risk of fire, accidents, and other hazards. A charge of .5 percent of the remaining value was allocated for insurance.

Equation 6.

Insurance Charge = (.005) (Remaining Value of Machine)

The majority of the farmers housed only their tractors, combines, and trucks. A charge of 1.5 percent of the remaining value was used.

Equation 7.

Shelter Expense = (.015) (Average Value of Shelter)

The variable costs are comprised of fuel, oil, labor, and repair and maintenance cost. These costs were calculated according to the following procedures:

Fuel consumption differs with soil conditions, terrain, and operators. The lack of accurate cost per gallon estimates has induced an average cost of $.35 per gallon of gasoline and a $.36 per gallon cost of diesel. Farmers may claim a tax credit covering only gasoline used in non-highway vehicles. In this study, the gasoline price has a 12.5 cent per gallon tax reduction. The following equations are taken from the A.S.A.E. [1]. The computer program calculates the average fuel cost with this formula.

Equation 8.

Fuel cost per hour = (cost per gallon) (gallons per hour)

Equation 9.

Gallons per hour = (.06) (Power take off horsepower of machine)

The power take off (P.T.O.) horsepower value was an average taken from the interviewed farmers.

A diesel engine will use approximately 73 percent as much fuel as a gasoline tractor.

Equation 10.

Diesel cost per hour = (cost per gallon) (gallons per hour) (.73)

In the computer program, oil cost per hour is 15 percent of the fuel cost.

Equation 11.

Oil cost = (fuel cost) (.15)

This expense does not include filters and oil other than crankcase oil. They are included in the repair and maintenance expense.

The labor charge of $3.00 was estimated by taking an average of the farmers' estimates. The labor was added to all farm power machinery costs.

The remaining variable costs consist of repairs and maintenance which cover costs of parts, repairs, lubrication, supplies, and service labor to perform these tasks. The costs are calculated from this formula.

Equation 12.

The total accumulated repairs (T.A.R.) is based on the formulae in Appendix Table 2. Dryland farm machinery was classified to fit an equation based on its estimated wear-out life. An example of a new four-wheel drive tractor used 500 hours with an estimated wear-out life of 12,000 hours will demonstrate how this works. Using, for example, Equation number 1 in Appendix Table 2. Where X is 100 times the ratio of total accumulated hours of use and the wear-out life of the machine, the following computation results:

$$\text{T.A.R. \%} = 0.100\ X^{1.5}$$

$$\text{T.A.R. \%} = (0.100)\left(\frac{1 \times 500 \times 100}{12{,}000}\right)^{1.5}$$

$$\text{T.A.R. \%} = 0.85\%$$

The 0.85 percent is used in Equation 12 to receive a repair and maintenance cost per hour for this particular tractor. This computation is done on a yearly basis with:

$$(\text{R \& M/Hour})_{\text{year } x} = \frac{\left(\text{Accumulated R\&M}_{\text{year } x}\right) - \left(\text{Accumulated R\&M}_{\text{year } x-1}\right)}{\text{Hours used in year } x}$$

The second objective was achieved by using regression analysis to develop Long-Run Planning Cost Curves for the dryland farmers in Latah, Power, and Bannock Counties.

Theoretically, the Long-Run Planning Cost Curve connects the minimum points of the average total cost curves for the individual farms in each county [3]. The Long-Run Planning Cost Curve is a locus of points representing the lowest average total cost of producing the corresponding outputs of total hours of use. The Long-Run Planning Cost Curves showed the cost per hour for a farmer's total machinery.

The long run is a planning horizon. The long run refers to the fact farmers may plan ahead and choose the method of future operation [3].

The analysis was principally concerned with development of Long-Run Planning Cost Curves and the determination of economies of size. Economies of size are a measure of the ability of a larger farm to produce a unit of output at a cost lower than that of a smaller farm. If economies of size exist, a 5,000 acre farm's total cost per acre was less than a 500 acre farm's total cost per acre. The degree of economies of size will be demonstrated by the downward slope of the Long-Run Planning Cost Curves.

Functional relationships were developed based on the farmers' total fixed and total variable costs. Total cost per hour and total cost per acre values were calculated in Equations 13 and 14. Annual hours of operation were based on the farmer's estimated information concerning the operation of his entire machinery group. These are average total cost values or unit cost values.

Equation 13.

$$\text{Total Cost Per Hour} = \frac{\text{Total Fixed Cost} + \text{Total Variable Cost}}{\text{Annual Hours of Operation}}$$

Equation 14.

$$\text{Total Cost Per Acre} = \frac{\text{Total Fixed Cost} + \text{Total Variable Cost}}{\text{Total Farm Acreage}}$$

Estimating Long-Run Planning Cost Curves

Regression analysis was used to develop Long-Run Planning Cost Curves for the three counties observed. The Long-Run Planning Cost Curves were based on average total cost values for the individual farms in the sample.

The Long-Run Planning Cost Curves were developed for the farmers in the three counties by applying mathematical functions to the unit cost values for the individual farms in the sample. Three mathematical functions were applied to the data: $Y=b_0X^{b_1}$, $e^Y=b_0X^{b_1}$, and $\frac{1}{y} = a + bX$. Those functions are approximations of the theoretical concept of Long-Run Planning Cost Curves. Scatter diagrams were produced (see Figures 11 through 16) and the mathematical function $\frac{1}{y} = a + bX$ was chosen. When the functions were tested, in every case it had the best fit of the three functions.

The mathematical function $\frac{1}{y} = a + bX$ was applied to the data to measure the relationship between average total cost per farm, total acreage per farm, and total annual hours of use. The dependent variable Y is the unit cost per farm, and $\frac{1}{y}$ is the reciprocal of the unit cost. The independent variable X is total acres or total hours of use for all machinery on a specified farm.

DATA PRESENTATION AND ANALYSIS

Machinery Cost Estimated by Computer Program

Economy of machinery cost is becoming an important management function as the expense of owning and operating farm machinery comprise a larger portion of farm costs. In order to realize the least cost per hour of operation, a machine must be used at or near its maximum capacity each season. The Computer Program received from Peterson [7] illustrates the yearly use that a machine may be used before its cost of operation increases.

Total cost-per-hour curves were developed for the dryland farm machinery in the three counties. The curves represent dryland farm machinery ranging in average age from 1 to 15 years and ranging in hourly use from 100 to 2,000 hours annually. Cost-per-hour values were reported and cost minimum points were indicated for the various dryland farm machinery. Beyond the minimum points, a farmer should consider purchasing a new machine because the total cost per hour of operation is less for a new machine used the same number of hours as the old machine. The older the machine, the greater the cost, as is illustrated by the tractors.

Tractors

Tractors are probably the most important machinery on the farm and comprise the largest portion of the machinery cost. This study has three classes of tractors, they are the 20 to 70 drawbar

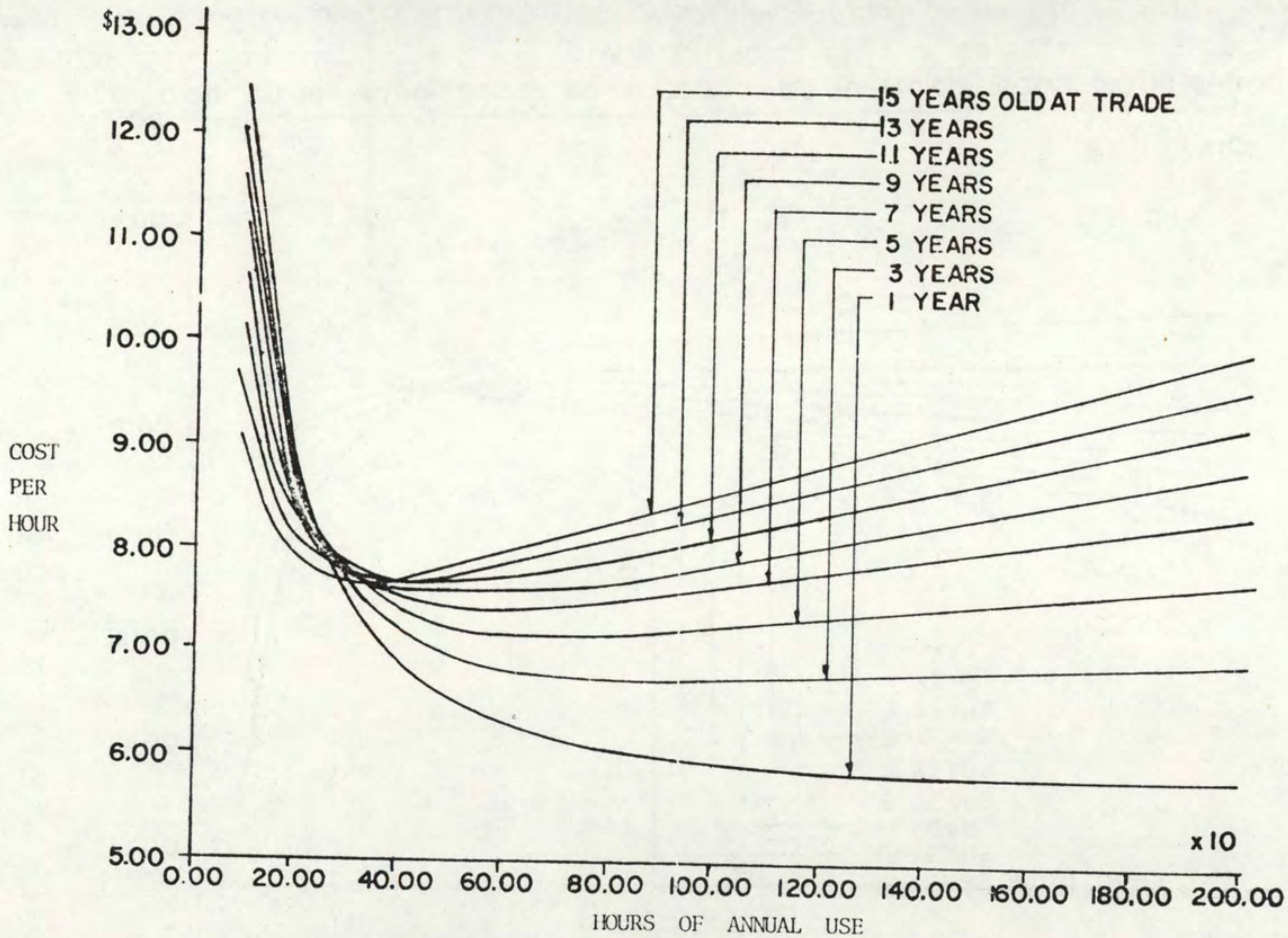

Figure 1. Total Cost Per Hour For 51 Tractors; 20 - 70 D.B.H.P Using the Straight Line Depreciation Method.

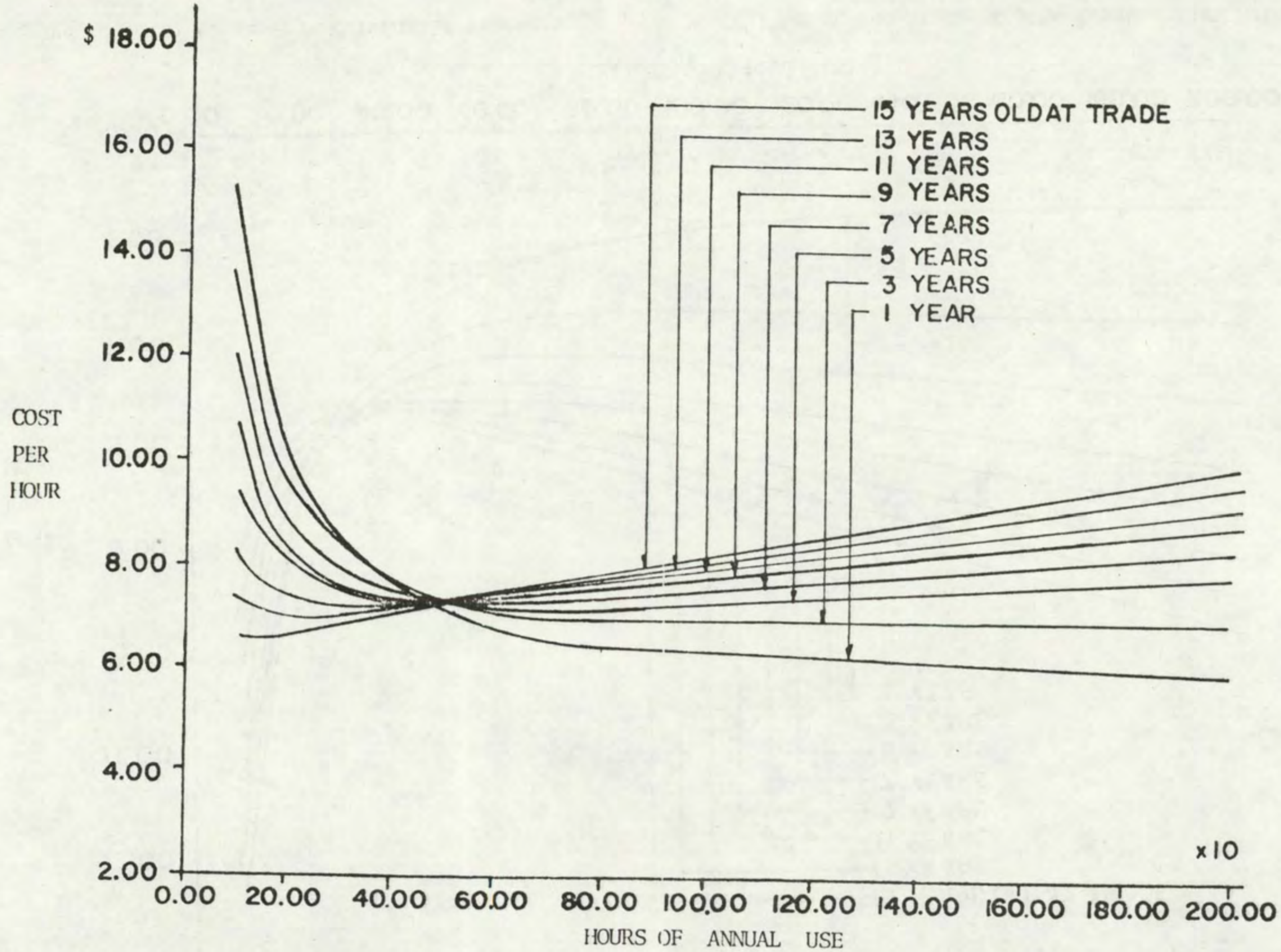

Figure 2. Total Cost Per Hour For 51 Tractors; 20 - 70 D.B.H.P Using Sum- of - the- Years' - Digits Depreciation.

horsepower class, 71 to 144 drawbar horsepower class, and the 145 to 225 drawbar horsepower class.

The 20 to 70 drawbar horsepower class consists of 51 tractors with an average age of 15 years. The tractors' lowest average total cost occurred at approximately 300 hours in 1974 at a total cost per hour of $7.69, using the Straight Line Depreciation method (see Table 2). According to Figure 1, a 7-year-old tractor has its lowest cost per hour at 600 hours of annual use. Beyond 600 hours of annual use, the repair and maintenance expense increases causing the total cost per hour curve to shift upward. The minimum cost occurs after 7 years of operating at 600 hours a year.

The Sum-of-the-Years'-Digits depreciation method allocates a large portion of the depreciation expense to the early years of a machine's life. For example, the 20 to 70 drawbar horsepower tractor class has a total cost per hour for a one-year-old tractor used 300 hours per year of $4.53 per hour, and for a seven-year-old tractor used 300 hours a year at a total cost per hour of $2.72. The minimum total cost per hour was reached at an annual use of 300 hours with a cost of $6.88 per hour (see Table 9). Based on the curves in Figure 2, the farmer should consider buying a new tractor every five years, if the tractor is used 700 hours per year. The minimum cost occurs at 700 hours per year for five years of operation (see Figure 2). Beyond this minimum point, the total cost per hour increases, making it economical for the farmer to purchase a new tractor. The new tractor will cost less per hour to operate than a seven-year-old tractor.

The most common size tractor was the 71 to 144 drawbar horsepower class. This class includes 58 tractors with an average age of 13 years. The tractors were used approximately 600 hours in 1974 at a total cost per hour of $9.14 (see Table 2). The respective minimums for the two methods occurred at $8.97 per hour for 900 hours of use, using the Straight Line depreciation, (see Figure 3) and at $8.22 per hour for 600 hours of use, using the Sum-of-the-Years'-Digits depreciation method (see Figure 4). The Sum-of-the-Years'-Digits costs were lower because of the lower depreciation cost. This accounts for the higher total cost associated with the Straight Line method of depreciation. The curves indicate that the cost per hour increases as the tractor becomes older. Repair and maintenance costs were responsible for the increase in costs for the older tractors.

The most expensive tractors to operate were the 145 to 225 drawbar horsepower class. This tractor class was comprised of 31 tractors with an average age of four years. A high purchase price was the major reason for the high operating cost. The high purchase price causes a high depreciation, taxes, insurance, shelter, and interest cost. The average purchase price was $20,275. These tractors were used an average of 600 hours in 1974 at a total cost per hour of $14.76, using the Straight Line depreciation method (see Table 2). The curves indicate that these tractors should be traded every nine years and a new tractor purchased if used over 1,000 hours a year. This was the minimum total cost point on the curves. Beyond 1,000 hours of use for nine-year-old tractors, the hourly cost will increase with increased annual use. For 1,000 hours

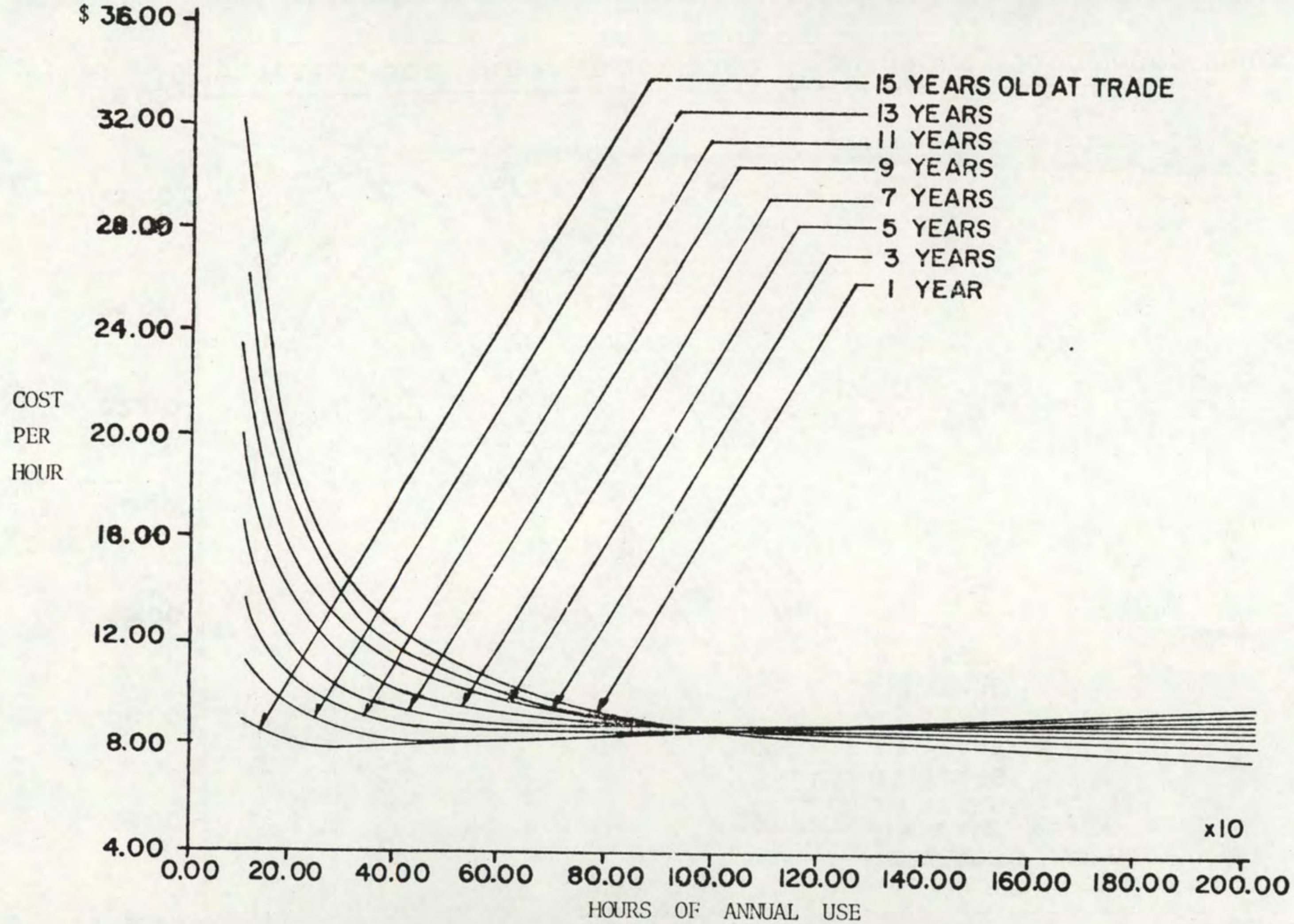

Figure 3. Total Cost Per Hour for 58 Tractors; 71 - 144 D.B.H.P Using Straight Line Depreciation.

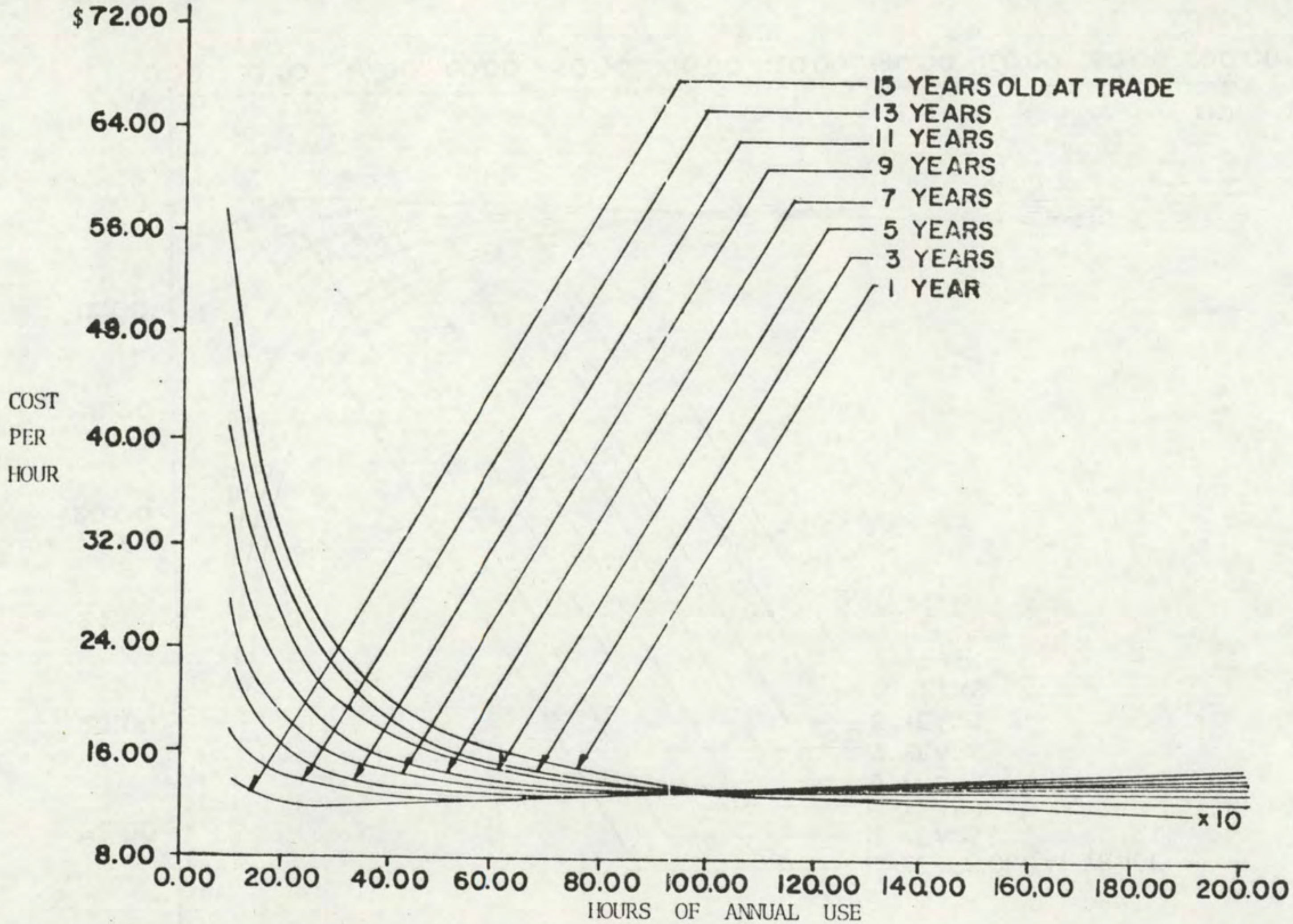

Figure 4. Total Cost Per Hour For 58 Tractors; 71 - 144 D.B.H.P Using Sum - of - the- Years' - Digits Depreciation.

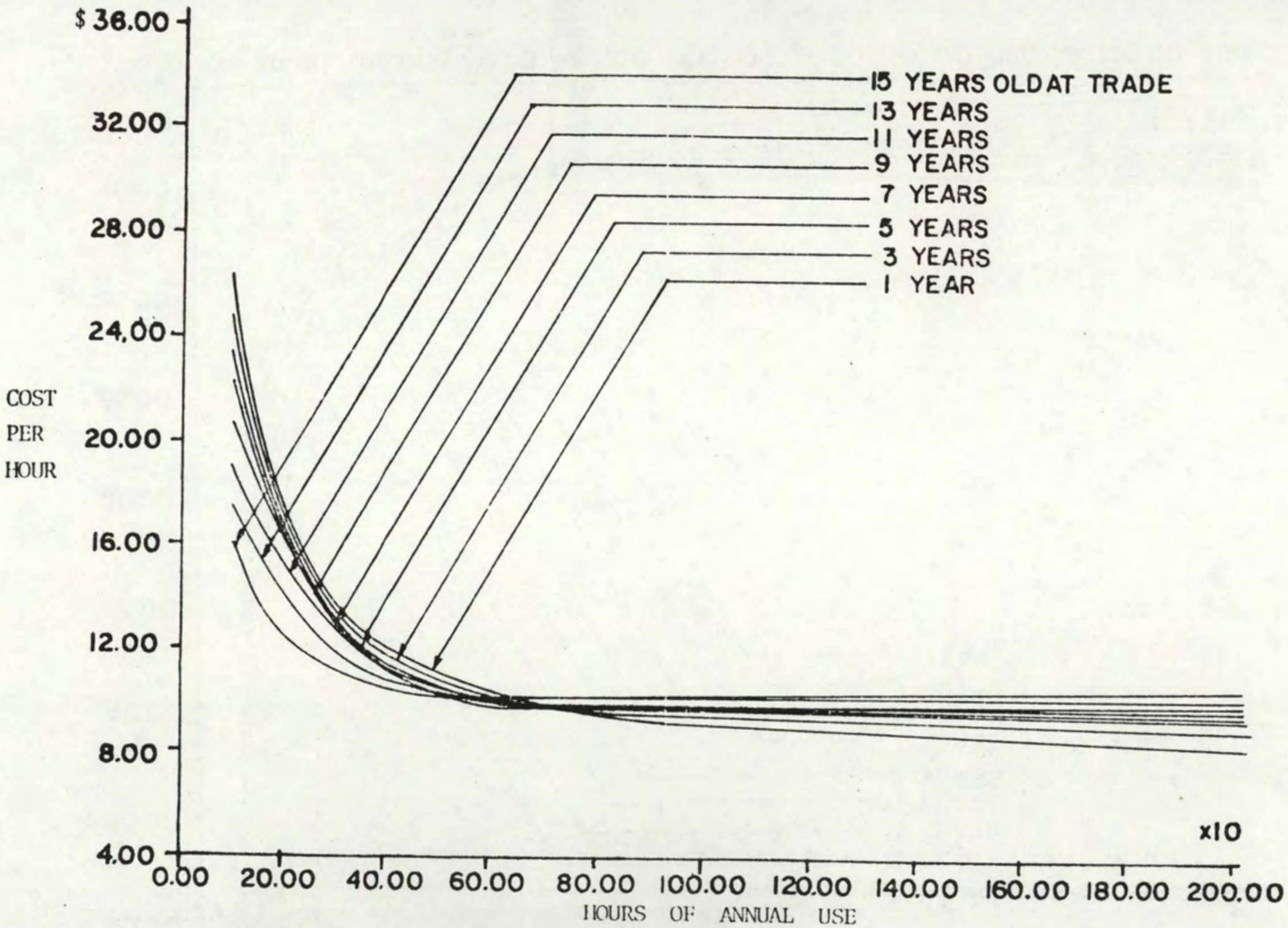

Figure 5. Total Cost Per Hour For 31 Tractors; 145 - 225 D.B.H.P Using Straight Line Depreciation.

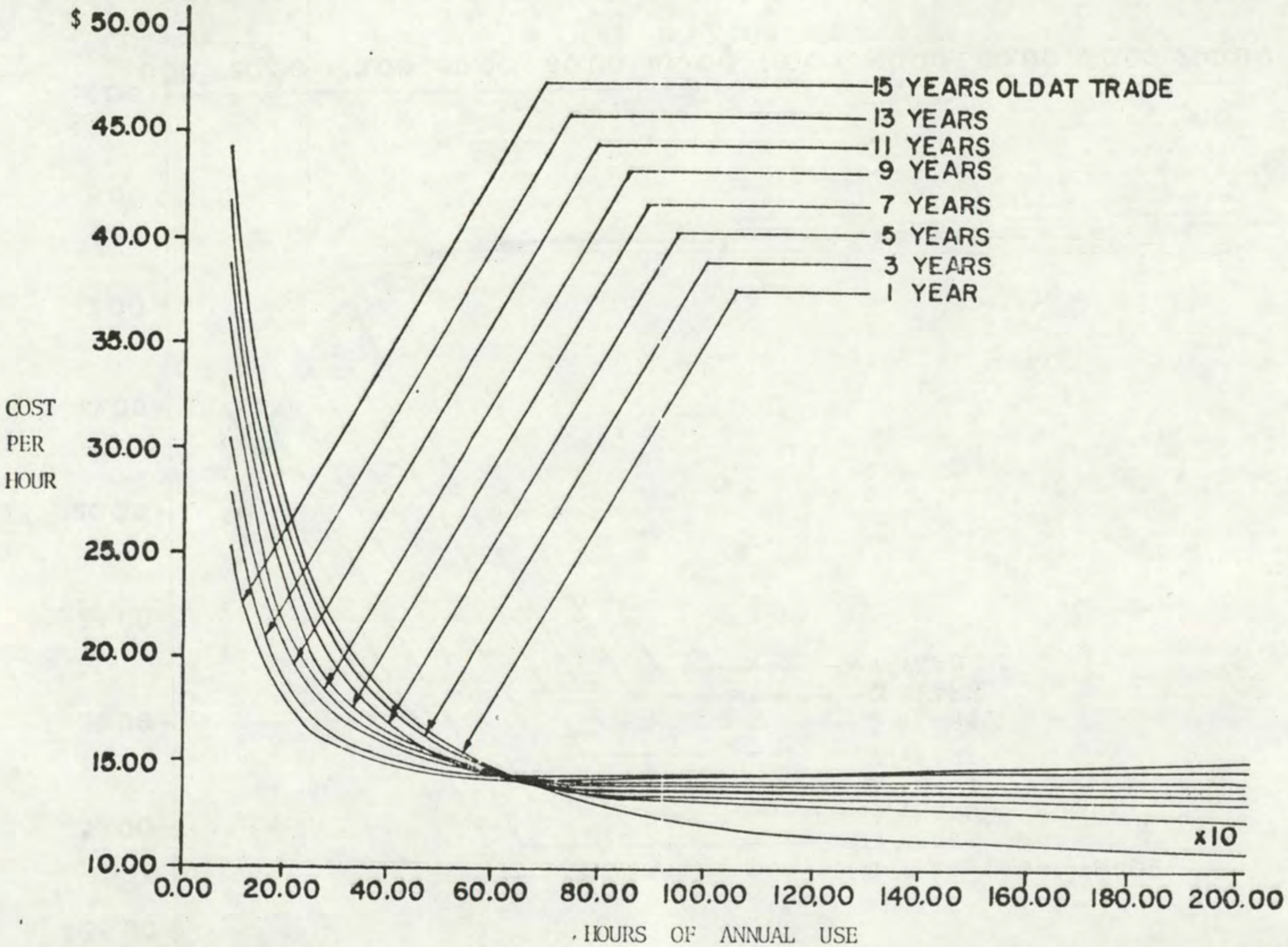

Figure 6. Total Cost Per Hour For 31 Tractors; 145-225 D.B.H.P Using Sum -of -the-Years' - Digits Depreciation.

of operation the total cost per hour of a new tractor was less than the total cost per hour of a nine-year-old tractor (see Figure 5).

Combines

Hillside combines were used in the three counties. The combines were grouped according to width of cut. The 12 to 16 foot class was comprised of 38 combines with an average purchase price of $14,167 and an average age of ten years. The average purchase prices were low in comparison with today's combine prices. However, the average purchase prices were based on information received from the farmers. These purchase prices were low; however, they were indicative of the sampled farmers' combines. The 12 to 16 foot combine class was operated an average of 200 hours in 1974 and using the Straight Line depreciation method, the total cost per hour was $19.79 (see Table 3). For the same age and hourly use, the Sum-of-the-Years'-Digits depreciation method indicates a total cost per hour of $14.52 (see Table 10). The major difference was the large allocation of depreciation cost to the early years of a machine's life by the Sum-of-the-Years'-Digits depreciation method.

Forty combines comprise the 18 to 20 foot swath class. The 18 to 20 foot combines have an average purchase price of $19,075. These combines were used an average of 300 hours in 1974 and have an average age of six years. The total cost per hour for 300 hours of operation, using the Straight Line depreciation method, was $21.18 (see Table 3). Using the Sum-of-the-Years'-Digits depreciation method, the total cost per hour for 300 hours of operation was $19.81

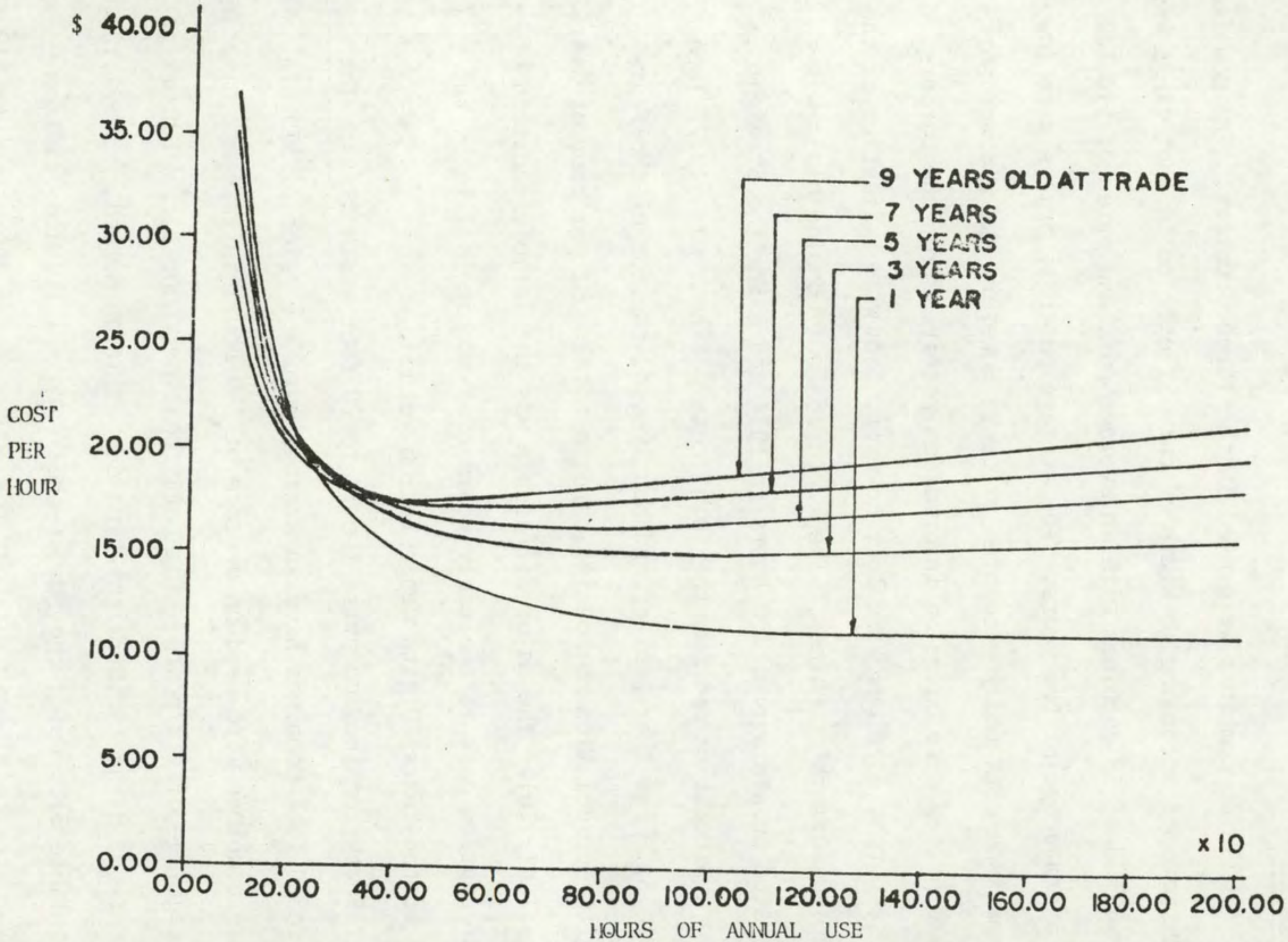

Figure 7. Total Cost Per Hour For 38 Combines; 12-16 Foot, Using Straight Line Depreciation.

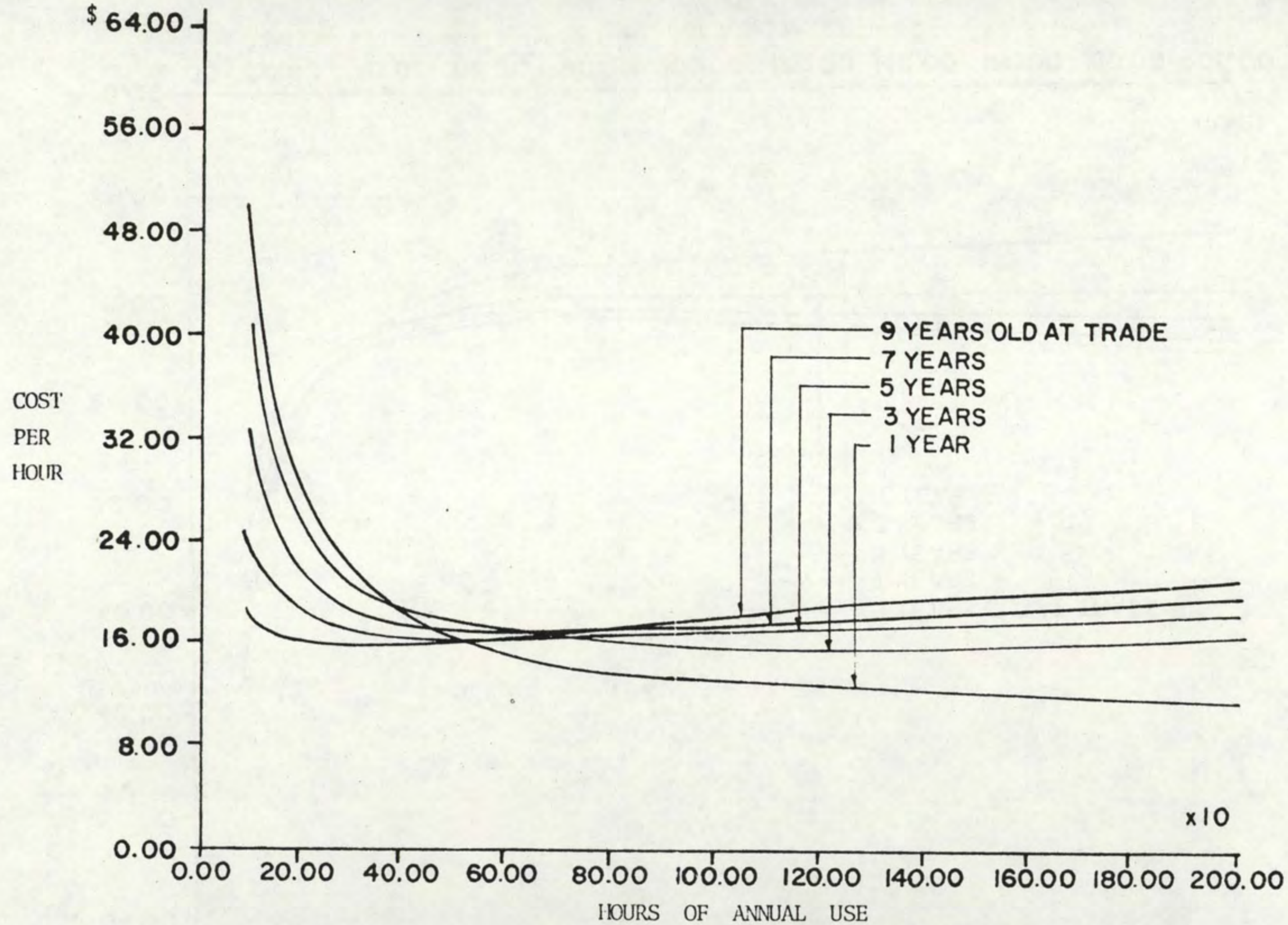

Figure 8. Total Cost Per Hour For 38 Combines; 12-16 Foot, Using Sum - of - the- Years' - Digits Depreciation.

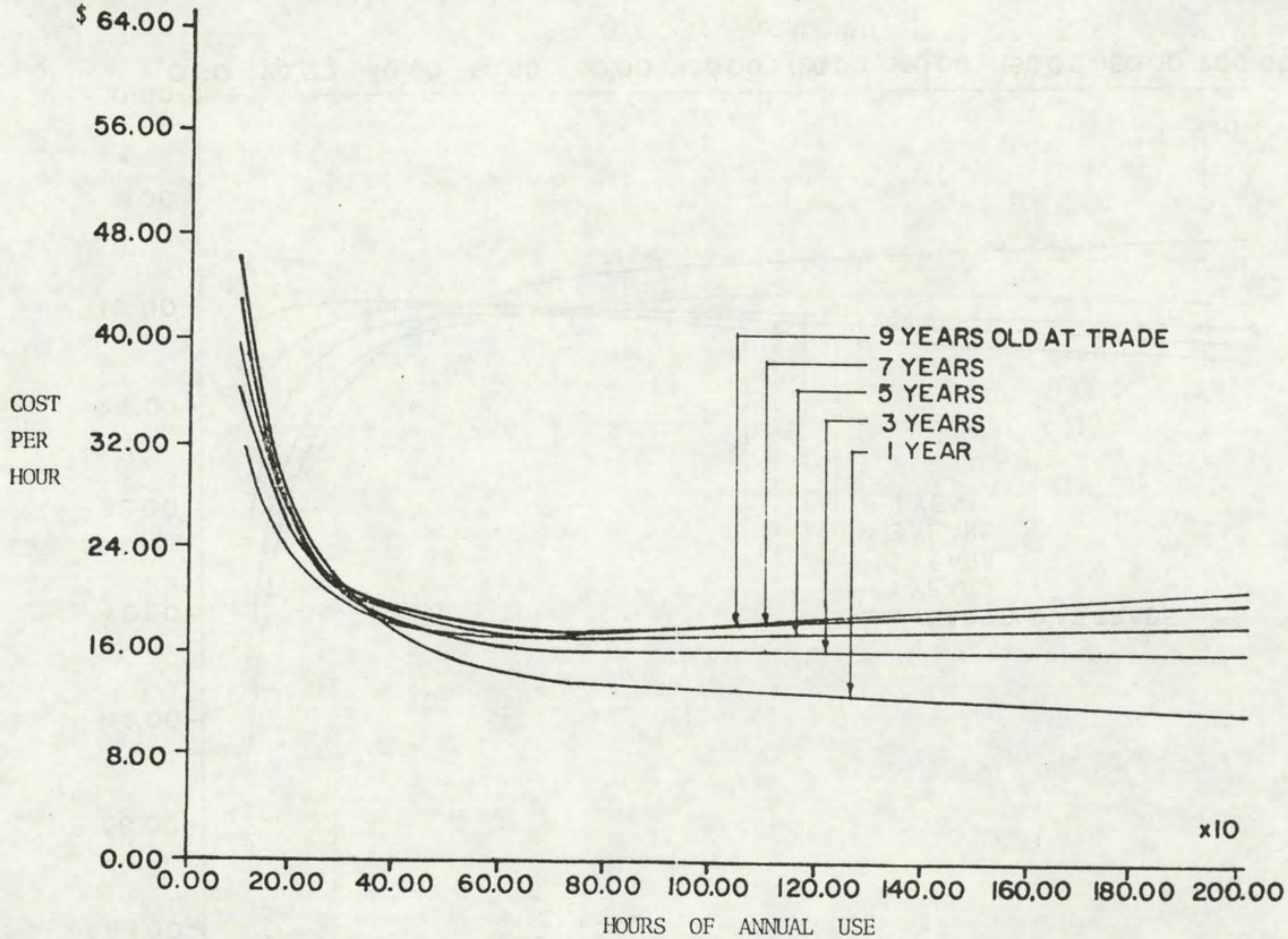

Figure 9. Total Cost Per Hour For 40 Combines; 18-20 Foot, Using Straight Line Depreciation.

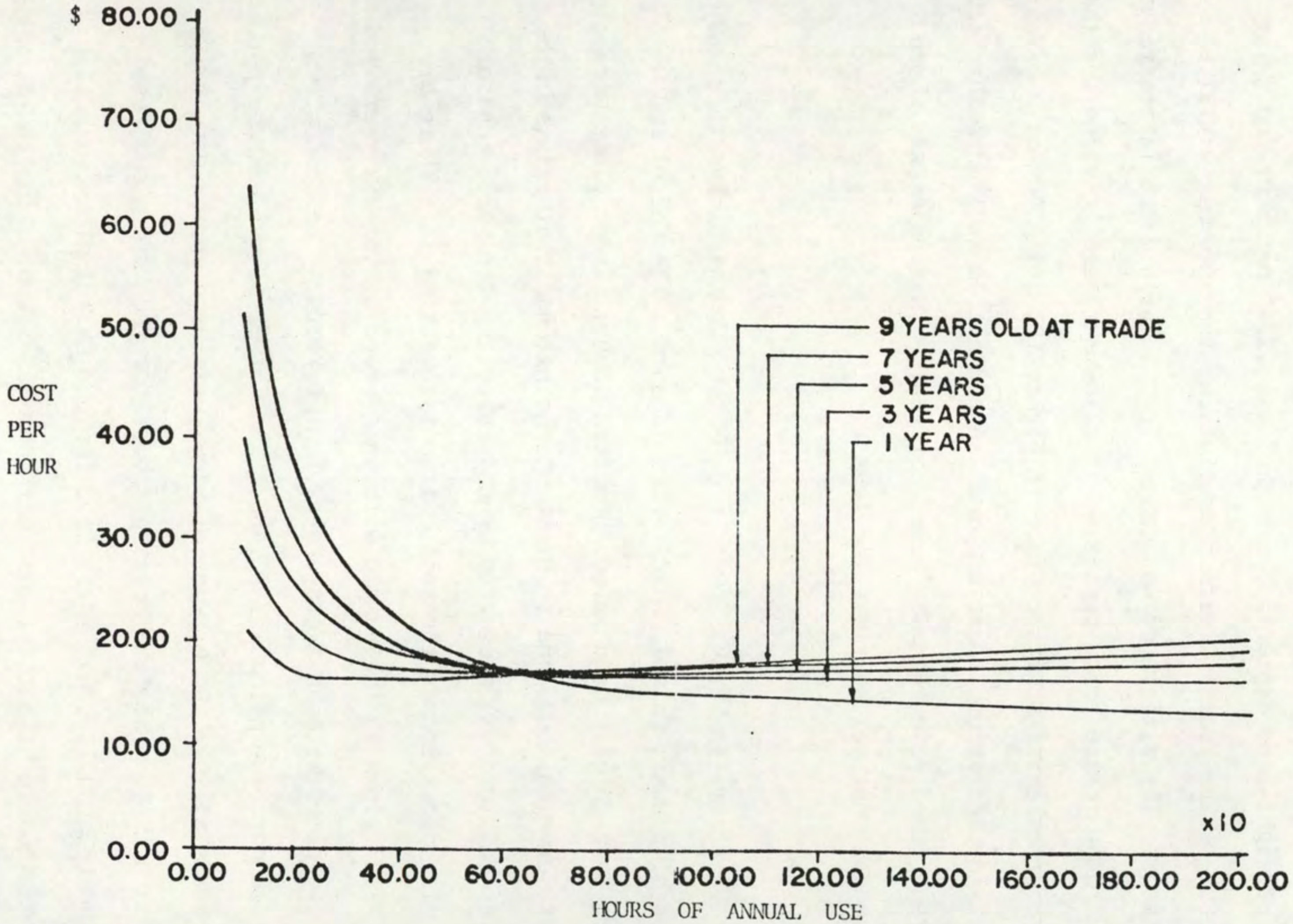

Figure 10. Total Cost Per Hour For 40 Combines; 18 -20 Foot, Using Sum - of - the - Years' - Digits Depreciation.

(see Table 10). In this instance, the taxes, insurance, shelter, and interest expense cause the Sum-of-the-Years'-Digits depreciation total cost to be lower. For example, the interest expense using the Straight Line depreciation method was $2.80 per hour and using the Sum-of-the-Years'-Digits depreciation, the interest was $1.85 per hour. The difference was caused from a large depreciation reduction from the purchase price resulting in a lower remaining value for the Sum-of-the-Years'-Digits costs. In Figure 10, using Sum-of-the-Years'-Digits depreciation, these combines should not be kept more than seven years if used more than 400 hours per year. This point was where the total cost per hour was the lowest.

Plows

The farms in Latah, Power, and Bannock Counties have three major types of plows: Chisel, Disc, and Moldboard. The Chisel and Disc plows were chiefly used in Southeastern Idaho. These plows were used to preserve moisture and to break-up the hardpan that exists in the soil. Moisture was preserved by not inverting the soil. Chisel and Disc plows loosen the soil, without inverting it. There are 30 Chisel plows in the sample with an average age of six years and 21 Disc plows with an average age of nine years. The Disc plows' average purchase price was $2,483. The Chisel plows' average purchase price was $1,991. Both types of plows were used approximately 100 hours in 1974. The total cost per hour for the Disc plows, used 100 hours annually, was $4.16, and for the Chisel plows, used 100 hours annually, the total cost per hour was $3.66, using the Straight Line depreciation method (see Table 4).

The Moldboard plow was the most common type of plow in the three counties surveyed. This class consists of 38 plows that have an average age of 12 years. The Moldboard plows' total cost per hour was $1.43 for 100 hours of annual use, using the Straight Line depreciation method (see Table 4). The cost for Moldboard plows was less than the Chisel and Disc Plows' cost because the Moldboard plows were older and have a lower average purchase price, thus lowering the Moldboard plows' total fixed cost.

Trucks

Information for 108 trucks was utilized in this study. These trucks have an average age of ten years and an average purchase price of $5,535. The hourly costs demonstrate similar characteristics to the other machinery. All costs decreased except the repair and maintenance cost. The minimum cost occurred at 400 hours of annual use. However, the farmers' estimates indicate that most farm trucks were not used over 100 hours per year or 3,000 miles per year. The total cost per hour for 100 hours was $16.38 (see Table 3). This was equal to a cost of $1,638 per year or $.55 per mile based on 3,000 miles of use per year. The cost per mile fluctuates, depending on the miles driven.

Tillage and Planting Machinery

The Sprayers, Packers, Harrows, Fertilizer Spreaders, and Grain Drills have a very short period of diminishing cost. The period ranges from approximately 100 to 300 hours of annual use. Beyond 300 hours of annual use, this group of machinery's cost rose sharply. Repair and maintenance costs comprise the largest portion of the machines' total cost. For example, a Grain Drill's total cost per hour using the Straight Line depreciation method for 100 hours of annual operation was $6.03 per hour; at 300 hours of use, the total cost per hour was $5.15 and at 500 hours of annual use, the hourly cost increases to $5.60 (see Table 6). The major reason was the repair and maintenance cost which increases from $2.58 per hour for 100 hours to $4.91 per hour for 500 hours of operation. The remaining machinery in this group have similar cost curves and cost values.

The Rodweeders, Cultivators, Rotovators, and Subsoilers have similar graphs to the previous tillage equipment. Rodweeders and Cultivators were used extensively, in fact, several farmers weed two or three times per year. There are 59 Rodweeders in the study with an average age of ten years, and 22 Cultivators with an average age of eight years. The minimum total cost per hour for both Rodweeders and Cultivators occurred at 500 hours of annual use. The Rodweeders' total cost per hour using the Straight Line depreciation method was $1.81 per hour and the Cultivators' cost using the same depreciation method was $1.53 per hour (see Table 7). The cost estimates produced for the Rotovators and Subsoilers were minutiae because of their limited number.

The Disc observed were of two types, the Offset and Tandem. This study has 69 Discs, with an average age of eight years, and an average purchase price of $2,028. The Discs were used approximately 100 hours in 1974 at a total cost of $3.51 per hour (see Table 8). Discs, like Rodweeders and Cultivators, may be used on the same acreage a number of times.

Replacement

As farm size continues to grow, efficient management becomes more and more important to the success of an enterprise. The cost estimates produced by the Computer Program can be used to aid in replacement decisions.

Timely replacement is important because of high cost and rapid changes in technology. The total cost-per-hour curves produced by the Computer Program show where replacement should occur. Replacement should be considered based on the machine's economic life. The machine's economic life ends when the machine's total cost per hour reaches a minimum. Beyond the minimum, total cost-per-hour increases in repair and maintenance costs make it uneconomical for the farmer to continue the machine's operation.

The past sections on tractors and combines demonstrate when replacement should be considered. By comparing the total cost-per-hour values, a farmer may decide to continue using the old machine or purchase a newer machine. The purchase of a newer machine will depend on the farmer's attitude and financial situation, however, when a machine reaches the end of its economic life, replacement should be considered.

For example, a tractor in the 20 to 70 drawbar horsepower group appears to have an economic life of five years at 500 hours of use per year. Beyond this point, the total cost per hour increases due to rising repair and maintenance cost. If financially possible, the farmer should consider purchasing a newer machine with a lower

Table 2.

Total Cost Per Hour for Varying Annual Use of Tractors Using Straight Line Depreciation[1/]

Machine	Annual Use in Hours						
51 Tractors (20 to 70 DBHP)	100	300	500	600	900	1200	1500
Average Age, 15 years							
Depreciation	$ 2.59	$ 0.86	$ 0.52	$ 0.43	$ 0.29	$ 0.22	$ 0.17
Tax, Insurance, Shelter	0.28	0.09	0.06	0.05	0.03	0.02	0.02
Interest	0.55	0.18	0.11	0.09	0.06	0.05	0.04
Repairs & Maintenance	1.17	2.03	2.62	2.87	3.52	4.05	4.53
Fuel and Labor	4.52	4.52	4.52	4.52	4.52	4.52	4.52
Total Cost Per Hour	$ 9.11	$ 7.69	$ 7.82	$ 7.96	$ 8.41	$ 8.86	$ 9.28
	Annual Use in Hours						
58 Tractors (71 to 144 DBHP)	100	300	500	600	900	1200	1500
Average Age, 13 years							
Depreciation	$ 6.53	$ 2.18	$ 1.31	$ 1.09	$ 0.73	$ 0.54	$ 0.44
Tax, Insurance, Shelter	1.22	0.41	0.24	0.20	0.14	0.10	0.08
Interest	2.44	0.81	0.49	0.41	0.27	0.20	0.16
Repairs & Maintenance	0.71	1.23	1.59	1.74	2.13	2.46	2.75
Fuel and Labor	5.70	5.70	5.70	5.70	5.70	5.70	5.70
Total Cost Per Hour	$16.60	$10.33	$ 9.33	$ 9.14	$ 8.97	$ 9.01	$ 9.14
	Annual Use in Hours						
31 Tractors (145 to 225 DBHP)	100	300	500	600	900	1200	1500
Average Age, 4 years							
Depreciation	$12.17	$ 4.06	$ 2.43	$ 2.03	$ 1.35	$ 1.01	$ 0.81
Tax, Insurance, Shelter	6.65	2.22	1.33	1.11	0.74	0.55	0.44
Interest	13.30	4.43	2.66	2.22	1.48	1.11	0.89
Repairs & Maintenance	0.71	1.23	1.59	1.75	2.14	2.47	2.76
Fuel and Labor	7.66	7.66	7.66	7.66	7.66	7.66	7.66
Total Cost Per Hour	$40.49	$19.60	$15.68	$14.76	$13.37	$12.81	$12.56

[1/] These values are based on the average ages of the machinery in the sample.

Table 3.

Total Cost Per Hour for Varying Annual Use of
Combines and Trucks Using Straight Line Depreciation

Machine	Annual Use in Hours					
38 Combines (12 to 16 Foot)	100	200	300	400	500	600
Average Age, 10 years						
Depreciation	$13.02	$ 6.51	$ 4.34	$ 3.26	$ 2.60	$ 2.17
Tax, Insurance, Shelter	1.10	0.55	0.37	0.27	0.22	0.18
Interest	2.20	1.10	0.73	0.55	0.44	0.37
Repairs & Maintenance	4.89	6.46	7.59	8.52	9.31	10.02
Fuel and Labor	5.17	5.17	5.17	5.17	5.17	5.17
Total Cost Per Hour	$26.39	$19.79	$18.21	$17.77	$17.75	$17.91
	Annual Use in Hours					
40 Combines (18 to 20 Foot)	100	200	300	400	500	600
Average Age, 6 years						
Depreciation	$17.17	$ 8.58	$ 5.72	$ 4.29	$ 3.43	$ 2.86
Tax, Insurance, Shelter	4.20	2.10	1.40	1.05	0.84	0.70
Interest	8.39	4.20	2.80	2.10	1.68	1.40
Repairs & Maintenance	3.61	4.76	5.60	6.29	6.87	7.39
Fuel and Labor	5.66	5.66	5.66	5.66	5.66	5.66
Total Cost Per Hour	$39.02	$25.30	$21.18	$19.38	$18.48	$18.01
	Annual Use in Hours					
108 Trucks	100	200	300	400	500	600
Average Age, 10 years						
Depreciation	$ 4.98	$ 2.49	$ 1.66	$ 1.25	$ 1.00	--
Tax, Insurance, Shelter	0.42	0.21	0.14	0.11	0.08	--
Interest	0.84	0.42	0.28	0.21	0.17	--
Repairs & Maintenance	2.31	3.04	3.58	4.01	4.39	--
Fuel and Labor	7.83	7.83	7.83	7.83	7.83	--
Total Cost Per Hour	$16.38	$13.99	$13.49	$13.40	$13.47	--

*These values are based on the average ages of the machinery in the sample.

Table 4 .

Total Cost Per Hour for Varying Annual Use of Plows Using Straight Line Depreciation

Machine	Annual Use in Hours				
38 Moldboard Plows (2 to 10 bt)	100	200	300	400	500
Average Age, 12 years					
Depreciation	$0.57	$0.29	$0.19	$0.14	$0.11
Tax, Insurance, Shelter	0.13	0.06	0.04	0.03	0.03
Interest	0.26	0.13	0.09	0.06	0.05
Repairs & Maintenance	0.47	0.58	0.65	0.71	0.76
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$1.43	$1.06	$0.97	$0.94	$0.95
	Annual Use in Hours				
30 Chisel Plows (7 to 26 ft)	100	200	300	400	500
Average Age, 6 years					
Depreciation	$1.19	$0.60	$0.40	$0.30	$0.24
Tax, Insurance, Shelter	0.56	0.28	0.19	0.14	0.11
Interest	1.12	0.56	0.37	0.28	0.22
Repairs & Maintenance	0.79	0.97	1.09	1.19	1.28
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$3.66	$2.41	$2.05	$1.91	$1.85
	Annual Use in Hours				
21 Disc Plows (10 to 24 ft)	100	200	300	400	500
Average Age, 9 years					
Depreciation	$1.49	$0.74	$0.50	$0.37	$0.30
Tax, Insurance, Shelter	0.52	0.26	0.17	0.13	0.10
Interest	1.03	0.52	0.34	0.26	0.21
Repairs & Maintenance	1.12	1.38	1.56	1.70	1.81
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$4.16	$2.90	$2.57	$2.46	$2.42

Table 5 .

Total Cost Per Hour for Varying Annual Use of Packers, Harrows, and Sprayers Using Straight Line Depreciation

Machine	Annual Use in Hours				
10 Packers	100	200	300	400	500
Average Age, 15 years					
Depreciation	$0.37	$0.19	$0.12	$0.09	$0.07
Tax, Insurance, Shelter	0.04	0.02	0.01	0.01	0.01
Interest	0.08	0.04	0.03	0.02	0.02
Repairs & Maintenance	1.08	1.34	1.51	1.64	1.76
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$1.57	$1.59	$1.67	$1.76	$1.86
	Annual Use in Hours				
10 Harrows	100	200	300	400	500
Average Age, 11 years					
Depreciation	$0.37	$0.19	$0.12	$0.09	$0.07
Tax, Insurance, Shelter	0.11	0.06	0.04	0.02	0.02
Interest	0.23	0.11	0.08	0.05	0.04
Repairs & Maintenance	0.96	1.18	1.33	1.49	1.60
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$1.67	$1.54	$1.57	$1.65	$1.73
	Annual Use in Hours				
16 Sprayers	100	200	300	400	500
Average Age, 5 years					
Depreciation	$0.16	$0.08	$0.05	$0.04	$0.03
Tax, Insurance, Shelter	0.08	0.04	0.03	0.02	0.02
Interest	0.17	0.08	0.06	0.04	0.03
Repairs & Maintenance	0.22	0.28	0.33	0.38	0.41
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$0.63	$0.48	$0.47	$0.48	$0.49

Table 6.

Total Cost Per Hour for Varying Annual Use of Fertilizer Spreaders, Rotovators, and Grain Drills Using Straight Line Depreciation

Machine	Annual Use in Hours				
6 Fertilizer Spreaders	100	200	300	400	500
Average Age, 8 years					
Depreciation	$0.53	$0.27	$0.18	$0.13	$0.11
Tax, Insurance, Shelter	0.21	0.10	0.07	0.05	0.04
Interest	0.41	0.21	0.14	0.10	0.08
Repairs & Maintenance	1.03	1.36	1.60	1.80	1.97
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$2.18	$1.94	$1.99	$2.08	$2.20
	Annual Use in Hours				
2 Rotovators	100	200	300	400	500
Average Age, 4 years					
Depreciation	$1.80	$0.90	$0.60	$0.45	$0.36
Tax, Insurance, Shelter	0.98	0.49	0.33	0.25	0.20
Interest	1.97	0.98	0.66	0.49	0.39
Repairs & Maintenance	1.04	1.28	1.44	1.57	1.68
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$5.79	$3.65	$3.03	$2.76	$2.63
	Annual Use in Hours				
45 Grain Drills (10 to 32 ft)	100	200	300	400	500
Average Age, 9 years					
Depreciation	$1.60	$0.80	$0.53	$0.40	$0.32
Tax, Insurance, Shelter	0.62	0.31	0.21	0.15	0.12
Interest	1.23	0.62	0.41	0.31	0.25
Repairs & Maintenance	2.58	3.41	4.00	4.69	4.91
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$6.03	$5.14	$5.15	$5.55	$5.60

Table 7.

Total Cost Per Hour for Varying Annual Use of Grain Drills, Cultivators and Rodweeders Using Straight Line Depreciation

Machine	Annual Use in Hours				
19 Grain Drills (33 to 72 ft)	100	200	300	400	500
Average age, 8 years					
Depreciation	$2.45	$1.23	$0.82	$0.61	$0.49
Tax, Insurance, Shelter	0.95	0.47	0.32	0.24	0.19
Interest	1.90	0.95	0.63	0.47	0.38
Repairs & Maintenance	3.96	5.23	6.15	6.90	7.55
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$9.26	$7.88	$7.92	$8.22	$8.61
	Annual Use in Hours				
22 Cultivators	100	200	300	400	500
Average age, 8 years					
Depreciation	$0.95	$0.48	$0.32	$0.24	$0.19
Tax, Insurance, Shelter	0.37	0.18	0.12	0.09	0.07
Interest	0.74	0.37	0.25	0.18	0.15
Repairs & Maintenance	0.69	0.85	0.96	1.05	1.12
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$2.75	$1.88	$1.65	$1.56	$1.53
	Annual Use in Hours				
59 Rodweeders	100	200	300	400	500
Average age, 10 years					
Depreciation	$1.15	$0.57	$0.38	$0.29	$0.23
Tax, Insurance, Shelter	0.35	0.18	0.12	0.09	0.07
Interest	0.70	0.35	0.23	0.18	0.14
Repairs & Maintenance	0.89	1.10	1.24	1.35	1.45
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$3.09	$2.20	$1.97	$1.91	$1.81

Table 8.

Total Cost Per Hour for Varying Annual Use of Discs
Using Straight Line Depreciation

Machine	Annual Use in Hours				
69 Discs	100	200	300	400	500
Average age, 8 years					
Depreciation	$1.22	$0.61	$0.41	$0.30	$0.24
Tax, Insurance, Shelter	0.47	0.24	0.16	0.12	0.09
Interest	0.94	0.47	0.31	0.24	0.19
Repairs & Maintenance	0.88	1.08	1.22	1.34	1.43
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$3.51	$2.40	$2.10	$2.00	$1.95

Table 9.

Total Cost Per Hour for Varying Annual Use of Tractors Using Sum-of-the-Years'-Digits Depreciation

Machine	Annual Use in Hours						
51 Tractors (20 to 70 DBHP)	100	300	500	600	900	1200	1500
Average Age, 15 years							
Depreciation	$ 0.36	$ 0.12	$ 0.07	$ 0.06	$ 0.04	$ 0.03	$ 0.02
Tax, Insurance, Shelter	0.22	0.07	0.04	0.04	0.02	0.02	0.01
Interest	0.43	0.14	0.09	0.07	0.05	0.04	0.03
Repairs & Maintenance	1.17	2.03	2.62	2.87	3.51	4.05	4.53
Fuel and Labor	4.52	4.52	4.52	4.52	4.52	4.52	4.52
Total Cost Per Hour	$ 6.70	$ 6.88	$ 7.34	$ 7.56	$ 8.14	$ 8.66	$ 9.12
	Annual Use in Hours						
58 Tractors (71 to 144 DBHP)	100	300	500	600	900	1200	1500
Average Age, 13 years							
Depreciation	$ 2.72	$ 0.91	$ 0.54	$ 0.45	$ 0.30	$ 0.23	$ 0.18
Tax, Insurance, Shelter	0.65	0.22	0.13	0.11	0.07	0.05	0.04
Interest	1.31	0.44	0.26	0.22	0.15	0.11	0.09
Repairs & Maintenance	0.71	1.23	1.59	1.74	2.13	2.46	2.75
Fuel and Labor	5.70	5.70	5.70	5.70	5.70	5.70	5.70
Total Cost Per Hour	$11.09	$ 8.49	$ 8.23	$ 8.22	$ 8.36	$ 8.56	$ 8.77
	Annual Use in Hours						
31 Tractors (145 to 225 DBHP)	100	300	500	600	900	1200	1500
Average Age, 4 years							
Depreciation	$20.28	$ 6.76	$ 4.06	$ 3.38	$ 2.25	$ 1.69	$ 1.35
Tax, Insurance, Shelter	5.47	1.82	1.09	0.91	0.61	0.46	0.36
Interest	10.95	3.65	2.19	1.82	1.22	0.91	0.73
Repairs & Maintenance	0.71	1.23	1.59	1.75	2.14	2.47	2.76
Fuel and Labor	7.66	7.66	7.66	7.66	7.66	7.66	7.66
Total Cost Per Hour	$45.07	$21.13	$16.59	$15.52	$13.88	$13.19	$12.87

*These values are based on the average ages of the machinery.

Table 10.

Total Cost Per Hour for Varying Annual Use of Combines and Moldboard Plows Using Sum-of-the-Years'-Digits Depreciation

Machine	Annual Use in Hours					
38 Combines (12 to 16 ft)	100	200	300	400	500	600
Average age, 10 years						
Depreciation	$ 2.63	$ 1.32	$ 0.88	$ 0.66	$ 0.53	$ 0.44
Tax, Insurance, Shelter	1.05	0.53	0.35	0.26	0.21	0.18
Interest	2.10	1.05	0.70	0.53	0.42	0.35
Repairs & Maintenance	4.89	6.46	7.59	8.52	9.31	10.02
Fuel and Labor	5.17	5.17	5.17	5.17	5.17	5.17
Total Cost Per Hour	$15.85	$14.52	$14.70	$15.15	$15.65	$16.16
	Annual Use in Hours					
40 Combines (18 to 20 ft)	100	200	300	400	500	600
Average age, 6 years						
Depreciation	$17.34	$ 8.67	$ 5.78	$ 4.34	$ 3.47	$ 2.89
Tax, Insurance, Shelter	2.77	1.39	0.92	0.69	0.55	0.46
Interest	5.55	2.77	1.85	1.39	1.11	0.92
Repairs & Maintenance	3.61	4.76	5.60	6.29	6.87	7.39
Fuel and Labor	5.66	5.66	5.66	5.66	5.66	5.66
Total Cost Per Hour	$34.93	$23.25	$19.81	$18.36	$17.66	$17.33
	Annual Use in Hours					
38 Moldboard Plows (2 to 10 bt)	100	200	300	400	500	600
Average age, 12 years						
Depreciation	$ 0.32	$ 0.16	$ 0.11	$ 0.08	$ 0.06	--
Tax, Insurance, Shelter	0.07	0.03	0.02	0.02	0.01	--
Interest	0.13	0.07	0.04	0.03	0.03	--
Repairs & Maintenance	0.47	0.58	0.65	0.71	0.76	--
Fuel and Labor	0.00	0.00	0.00	0.00	0.00	--
Total Cost Per Hour	$ 0.99	$ 0.84	$ 0.82	$ 0.84	$ 0.86	--

Table 11.

Total Cost Per Hour for Varying Annual Use of Chisel Plows, Disc Plows, and Packers Using Sum-of-the-Years' Digits Depreciation

Machine	Annual Use in Hours				
30 Chisel Plows (7 to 26 ft)	100	200	300	400	500
Average Age, 6 years					
Depreciation	$1.66	$0.83	$0.55	$0.41	$0.33
Tax, Insurance, Shelter	0.40	0.20	0.13	0.10	0.08
Interest	0.80	0.40	0.27	0.20	0.16
Repairs & Maintenance	0.79	0.97	1.09	1.19	1.28
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$3.65	$2.40	$2.04	$1.90	$1.85
	Annual Use in Hours				
21 Disc Plows (10 to 24 ft)	100	200	300	400	500
Average Age, 9 years					
Depreciation	$1.45	$0.72	$0.48	$0.36	$0.29
Tax, Insurance, Shelter	0.30	0.15	0.10	0.07	0.06
Interest	0.60	0.30	0.20	0.15	0.12
Repairs & Maintenance	1.12	1.38	1.56	1.70	1.81
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$3.47	$2.55	$2.34	$2.28	$2.28
	Annual Use in Hours				
10 Packers	100	200	300	400	500
Average Age, 15 years					
Depreciation	$0.05	$0.03	$0.02	$0.01	$0.01
Tax, Insurance, Shelter	0.03	0.02	0.01	0.01	0.01
Interest	0.06	0.03	0.02	0.02	0.01
Repairs & Maintenance	1.08	1.34	1.51	1.64	1.76
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$1.22	$1.42	$1.56	$1.68	$1.79

Table 12.

Total Cost Per Hour for Varying Annual Use of Harrows, Rotovators, and Grain Drills Using Sum-of-the-Years'-Digits Depreciation

Machine	Annual Use in Hours				
10 Harrows	100	200	300	400	500
Average Age, 11 years					
Depreciation	$0.26	$0.13	$0.09	$0.06	$0.05
Tax, Insurance, Shelter	0.05	0.03	0.02	0.01	0.01
Interest	0.10	0.05	0.03	0.03	0.02
Repairs & Maintenance	0.98	1.21	1.37	1.49	1.60
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$1.39	$1.42	$1.51	$1.59	$1.68
	Annual Use in Hours				
2 Rotovators	100	200	300	400	500
Average Age, 4 years					
Depreciation	$3.00	$1.50	$1.00	$0.75	$0.60
Tax, Insurance, Shelter	0.81	0.40	0.27	0.20	0.16
Interest	1.62	0.81	0.54	0.40	0.32
Repairs & Maintenance	1.04	1.28	1.44	1.57	1.68
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$6.47	$3.99	$3.25	$2.92	$2.76
	Annual Use in Hours				
45 Grain Drills (10 to 32 ft)	100	200	300	400	500
Average Age, 9 years					
Depreciation	$1.55	$0.78	$0.52	$0.39	$0.31
Tax, Insurance, Shelter	0.32	0.16	0.11	0.08	0.06
Interest	0.64	0.32	0.21	0.16	0.13
Repairs & Maintenance	2.71	3.58	4.21	4.72	5.17
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$5.22	$4.84	$5.05	$5.35	$5.67

Table 13.

Total Cost Per Hour for Varying Annual Use of Grain Drills, Sprayers, and Cultivators Using Sum-of-the-Years'-Digits Depreciation

Machine	Annual Use in Hours				
19 Grain Drills (33 to 72)	100	200	300	400	500
Average Age, 8 years					
Depreciation	$2.73	$1.36	$0.91	$0.68	$0.55
Tax, Insurance, Shelter	0.59	0.29	0.20	0.15	0.12
Interest	1.17	0.59	0.39	0.29	0.23
Repairs & Maintenance	3.96	5.23	6.15	6.90	7.55
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$8.18	$7.47	$7.65	$8.02	$8.45

	Annual Use in Hours				
16 Sprayers	100	200	300	400	500
Average Age, 5 years					
Depreciation	$0.25	$0.13	$0.08	$0.06	$0.05
Tax, Insurance, Shelter	0.06	0.03	0.02	0.02	0.01
Interest	0.13	0.06	0.04	0.03	0.03
Repairs & Maintenance	0.22	0.28	0.33	0.38	0.41
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$0.66	$0.50	$0.47	$0.49	$0.50

	Annual Use in Hours				
22 Cultivators	100	200	300	400	500
Average Age, 8 years					
Depreciation	$1.06	$0.53	$0.35	$0.26	$0.21
Tax, Insurance, Shelter	0.23	0.11	0.08	0.06	0.05
Interest	0.46	0.23	0.15	0.11	0.09
Repairs & Maintenance	0.69	0.85	0.96	1.05	1.12
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$2.44	$1.72	$1.54	$1.48	$1.47

Table 14.

Total Cost Per Hour for Varying Annual Use of Rodweeders, Discs, and Fertilizer Spreaders Using Sum-of-the-Years'-Digits Depreciation

Machine	Annual Use in Hours				
59 Rodweeders	100	200	300	400	500
Average Age, 10 years					
Depreciation	$0.96	$0.48	$0.32	$0.24	$0.19
Tax, Insurance, Shelter	0.19	0.10	0.06	0.05	0.04
Interest	0.38	0.19	0.13	0.10	0.08
Repairs & Maintenance	0.89	1.10	1.24	1.35	1.45
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$2.42	$1.87	$1.75	$1.74	$1.76
	Annual Use in Hours				
69 Discs	100	200	300	400	500
Average Age, 8 years					
Depreciation	$1.35	$0.68	$0.45	$0.34	$0.27
Tax, Insurance, Shelter	0.29	0.15	0.10	0.07	0.06
Interest	0.58	0.29	0.19	0.15	0.12
Repairs & Maintenance	0.88	1.08	1.22	1.34	1.43
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$3.10	$2.20	$1.96	$1.90	$1.88
	Annual Use in Hours				
6 Fertilizer Spreaders	100	200	300	400	500
Average Age, 8 years					
Depreciation	$0.59	$0.30	$0.20	$0.15	$0.12
Tax, Insurance, Shelter	0.13	0.06	0.04	0.03	0.03
Interest	0.25	0.13	0.08	0.06	0.05
Repairs & Maintenance	1.03	1.36	1.60	1.80	1.97
Fuel and Labor	0.00	0.00	0.00	0.00	0.00
Total Cost Per Hour	$2.00	$1.85	$1.92	$2.04	$2.17

Table 15.

Total Cost Per Hour for Varying Annual Use of Trucks
Using Sum-of-the-Years'-Digits Depreciation

Machine	Annual Use in Hours				
108 Trucks	100	200	300	400	500
Average Age, 10 years					
Depreciation	$ 1.01	$ 0.50	$ 0.34	$ 0.25	$ 0.20
Tax, Insurance, Shelter	0.40	0.20	0.13	0.10	0.08
Interest	0.81	0.40	0.27	0.20	0.16
Repairs & Maintenance	2.31	3.04	3.58	4.01	4.39
Fuel and Labor	7.83	7.83	7.83	7.83	7.83
Total Cost Per Hour	$12.36	$11.97	$12.15	$12.39	$12.66

total cost-per-hour value. However, the curves indicate that replacement should be considered but other factors such as income tax, price, investment credit, and inflation influence the replacement decision.

The unit cost curves produced for each depreciation method indicate that economies of scale exist until the cost curves reach a minimum. Then the curves move upward because the repair and maintenance cost increase.

The Sum-of-the-Years'-Digits depreciation method, in comparison to the Straight Line depreciation method, has a lower total cost per hour for older machines. This can be attributed to the fact that the Sum-of-the-Years'-Digits depreciation allocated a large portion of its cost to the earlier years of a machine's life. Almost in every class, the Straight Line depreciation costs were higher with the exception of the 145 to 225 drawbar horsepower class, the 18 to 20 foot combine class, and the Chisel plow group. These classes have a higher Sum-of-the-Years'-Digits total cost per hour than the Straight Line depreciation method because of their low age. The tax, insurance, shelter, and interest cost were also lower when the Sum-of-the-Years'-Digits depreciation method was used.

Machinery Cost Estimated by Regression Analysis

Cost-Per-Hour Estimates

The cost-per-hour values were calculated by allocating costs using the methods described in the empirical procedures section. The analysis was principally concerned with development of Long-Run

Planning Cost Curves and the determination of economies of size. The Planning Cost Curves developed demonstrate some economies of size. The downward sloping curves indicate that the more a group of machinery was used, the less the expense per hour. The Planning Cost Curves indicate that total cost per hour decreased through the entire range of use.

The Long-Run Planning Cost Curves were developed by regression analysis. However, the regression analysis curve indicates a much longer period of diminishing costs. In fact, the Planning Cost Curves gave no indication of moving upward. The unit cost continually decreases as use increases.

The Long-Run Planning Cost Curve for dryland farms in Latah County was derived from the equation $Y = 1/.0439 + .00002X$. This equation has a correlation coefficient of .70 and the regression coefficient was significant at the 95 percent level. The curve produced was a continual downward sloping unit cost curve that exhibits economies of size. The highest cost on the curve occurs at 2,000 hours of use at a cost of $14.20 per hour. The downward slope of the total cost-per-hour curve was caused by the declining of average fixed cost as use increases.

In this study, a downward slope to the right was an indication of economies of size, which means that the more a group of dryland farm machinery was used, the less the cost per unit. For example, it will cost a farmer in Latah County $13.30 an hour to operate his machinery 2,000 hours a year. If the farmer operates aggregately his machinery 7,000 hours a year, it will cost only $5.60 per hour

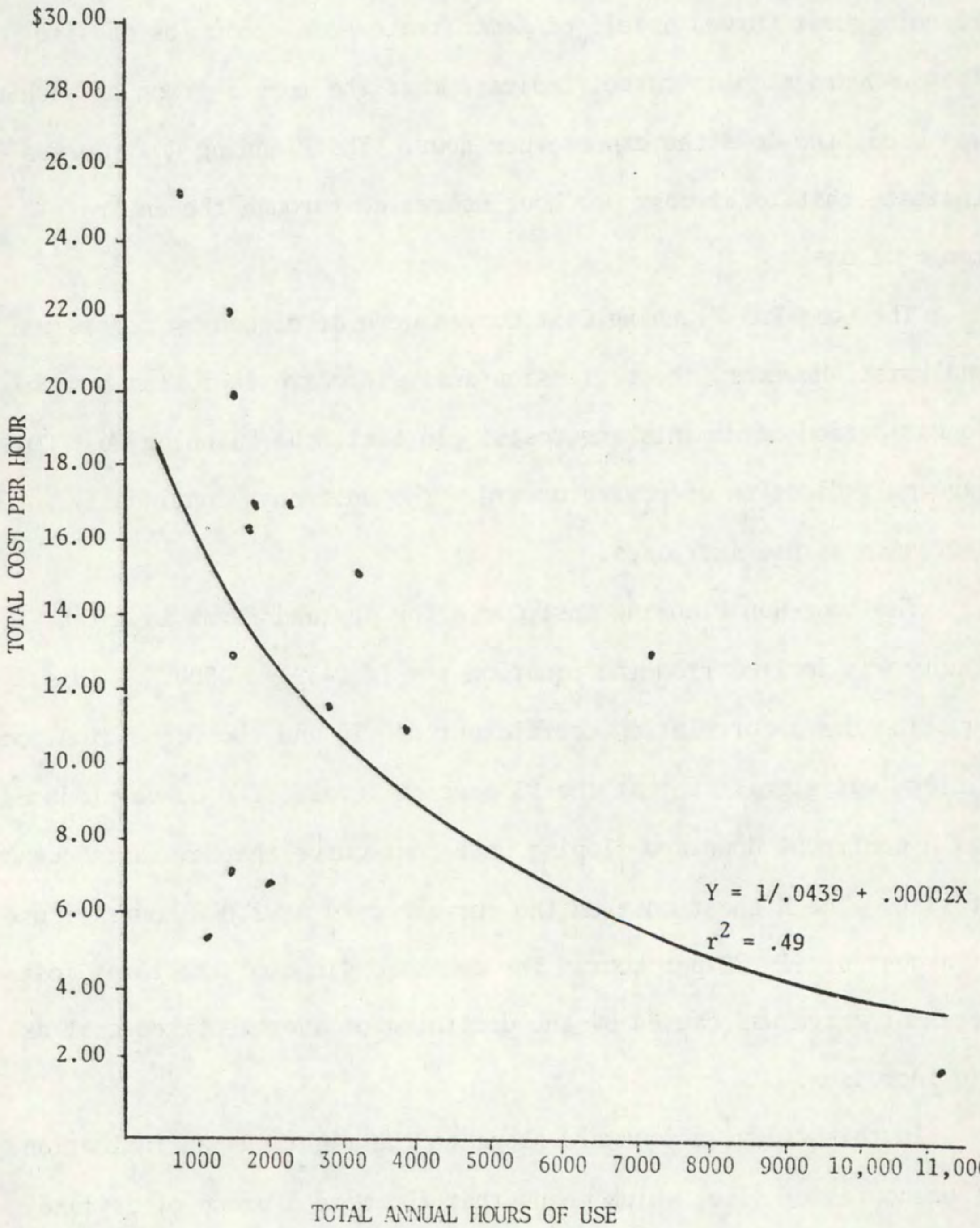

Figure 11. Relationship Between Total Operating Cost of Machinery and Total Annual Hours of Use for 15 Dryland Farms in Latah County, 1974 Cropyear.

(see Figure 11).

The fifteen farmers who were interviewed in Latah County used their machinery an average of 3,015 hours in 1974 at a cost of \$11.35 per hour. The average farm in Latah County has a total cost of \$34,220 of which fuel comprises 10 percent of the total cost, and labor, repairs and maintenance cost comprise 34 percent. The fixed costs account for 54 percent of the total cost. The remaining two percent was comprised of oil, grease, andfilters (see Table 16).

The regression cost curve for Power County (see Figure 12) was similar in shape to the curve representing Latah County. The curve was plotted from the equation Y = 1/.02461 + .00003X. The unit cost curve slopes down and to the right. The relationship between total cost per hour and total hours of use shows a correlation coefficient of .78, and the regression coefficient was significant at the 95 percent level. The unit cost curve decreases throughout the full range of machinery use. The curve starts at 1,800 hours of use per year at an expense of \$13.00 per hour, and continually decreases to 11,000 hours of annual use at a cost of \$2.60 per hour. Power County's curve demonstrates greater economies of size than does Latah County's curve. A low labor cost accounts for greater economies of size. The hourly costs in Power County were lower than those in Latah County. For example, a farmer's cost for 2,000 hours of operation was \$11.80 per hour, and for 7,000 hours it was \$4.30 per hour. Compared to Latah County's cost for 2,000 hours of operation, there was a difference of \$1.28 per hour.

The dryland farm machinery for 15 farms in Power County was used

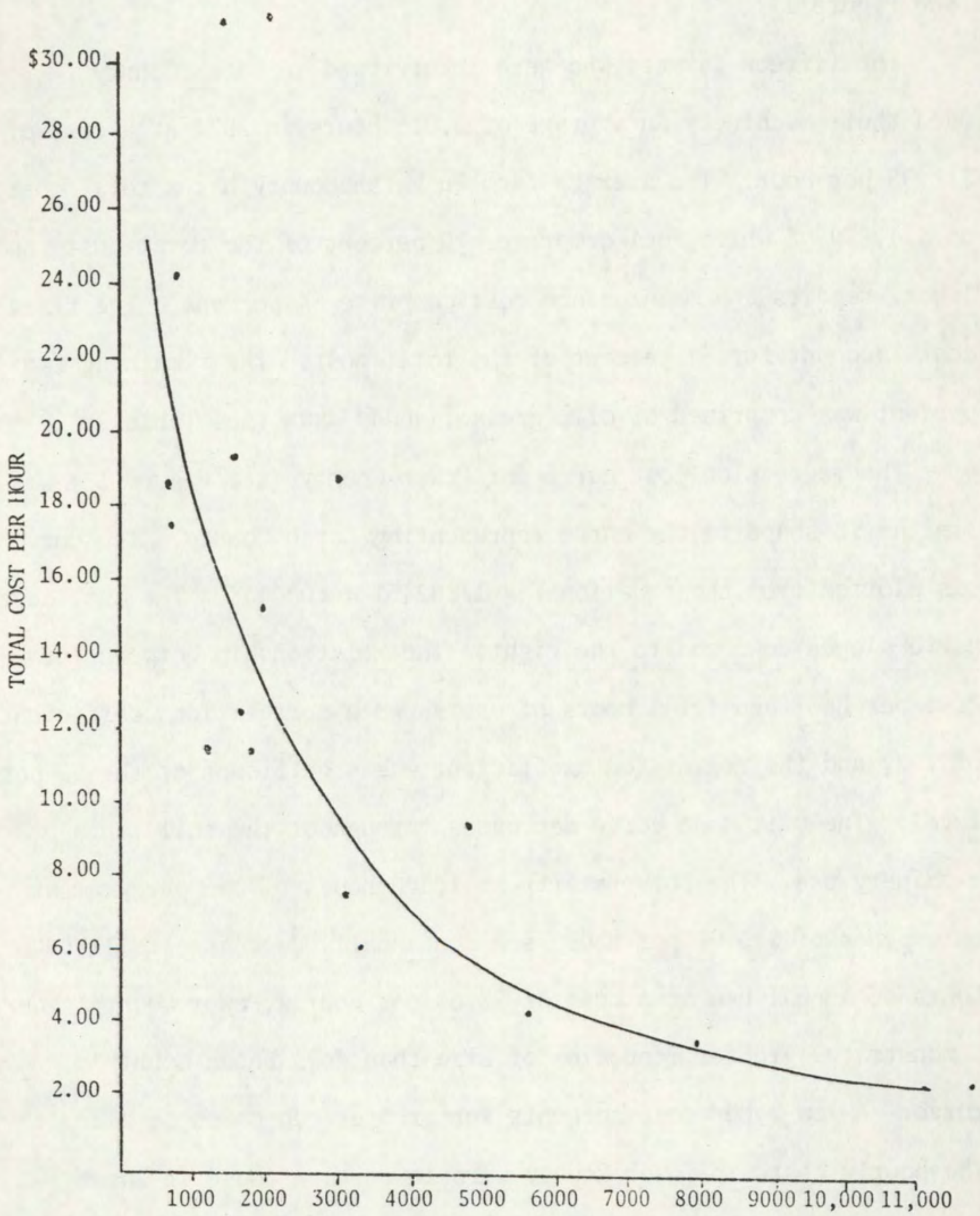

Figure 12. Relationship Between Total Operating Cost of Machinery and Total Annual Hours of Use for 15 Dryland Farms in Power County, 1974 Cropyear.

Table 16.

Percentage Received From Questionnaire of Total Machinery Cost Comprised by Each Individual Cost Item in Latah, Power, and Bannock Counties for Cropyear 1974

	Latah	Power	Bannock
Fuel	10.0%	14.0%	15.0%
Oil	1.0%	.5%	.5%
Filters	1.0%	.5%	.5%
Labor	17.0%	12.0%	22.0%
Repairs & Maintenance	17.0%	15.0%	17.0%
Depreciation, Taxes, Insurance, and Shelter	54.0%	58.0%	45.0%

an average of 2,400 hours a year at a cost of $11.00 per hour. This is a total cost of $24,742 a year. Fixed costs were the largest expense, accounting for 58 percent of the total cost. Repairs and maintenance were the second largest expense; they account for 15 percent of the total cost (see Table 16).

The regression cost curve for Bannock County farms was sketched from points calculated by the equation Y = 1/.03812 + .00002X. The relationship between total cost per hour and total hours of use shows a correlation coefficient of .48. The regression coefficient was significant at the 90 percent level. The curve was downward sloping, with similar characteristics of the two previous curves. The dryland farms in Bannock County also exhibit economies of size. For example, if a group of machinery was used 2,000 hours, it would cost $12.90 per hour, and if it was used 7,000 hours, it would cost $5.80 per hour (see Figure 16).

The average use of a farm's machinery in Bannock County was 1,848 hours a year at an expense of $13.10 per hour. Thus, the average farmer that used his machinery 1,848 hours last year has a total machinery cost of $24,209. The largest variable cost was labor, which comprised 22 percent of the total cost per year. The fixed costs were the largest expenses, accounting for 45 percent of the yearly total cost (see Table 16).

Comparing the total cost-per-hour curves, it was evident that Power County has the greatest degree of economies of size, due to the low labor, repair, and maintenance cost. Power County farmers have a lower labor and repair and maintenance cost because the county's

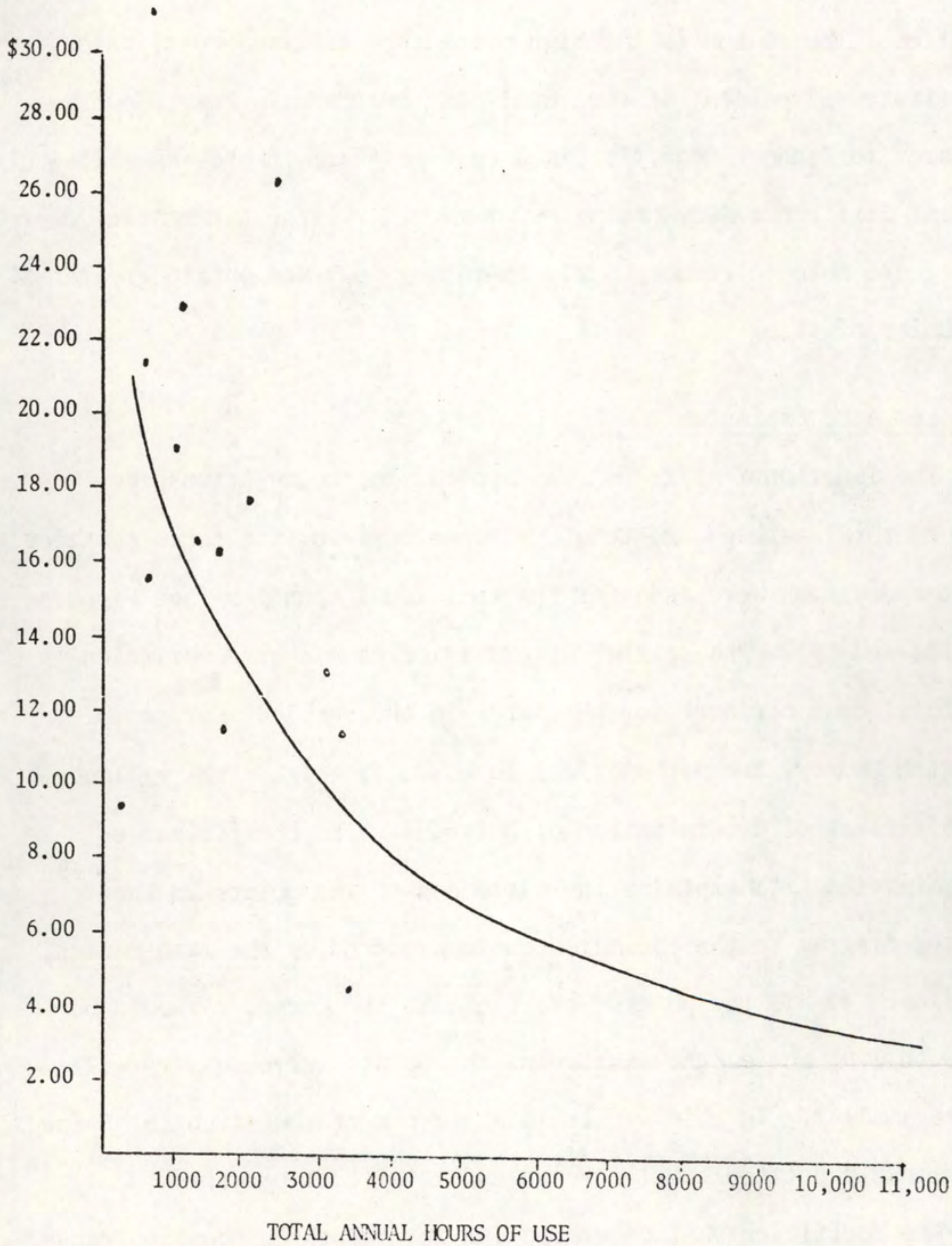

Figure 13. Relationship Between Total Operating Cost of Machinery and Total Annual Hours of Use for 15 Dryland Farms in Bannock County, 1974 Cropyear.

farmers have newer machinery than the farmers in Latah and Bannock Counties. The reason is the high percentage of fixed cost, which constitutes 58 percent of the total cost per farm in Power County. Compared to Bannock County's fixed cost per farm, there was a 13 percent difference. By having newer machinery, the farmers in Power County are able to reduce hourly operating cost and obtain greater economies of size.

Cost Per Acre Estimates

The function $Y = 1/(a+bX)$ was applied to the relationship between total acreage and total cost per acre for the three counties. Scatter diagrams were made for the individual counties (see Figures 14, 15, and 16). The scatter diagrams indicate a wide variation in the total cost per acre for the farms in the sample. For example, in Latah County, the mathematical function ($Y = 1/a + bX$) yielded a coefficient of determination of only .04. The coefficient of determination (r^2) explains the closeness of the points in the scatter diagram to the estimated curve produced by the mathematical function. If all the points were close to the curve, r^2 would be close to 1.0; but as the scatter of the points increases, r^2 will become smaller. In this way it is a measure of the strength of the relationship between total acreage and total cost per acre.

The coefficients of determination for the three counties ranged from .02 to .08. Therefore, based on the above analysis, the relationships between total acreage and total cost per acre were not explained by the function. Specifically, the total cost per acre computed from the data obtained from the farmers were scattered so widely that the mathematical function gave no reliable results. The reasons for the low coefficients of determination were the various method of farming and a high variation in the costs and mostly the small sample size.

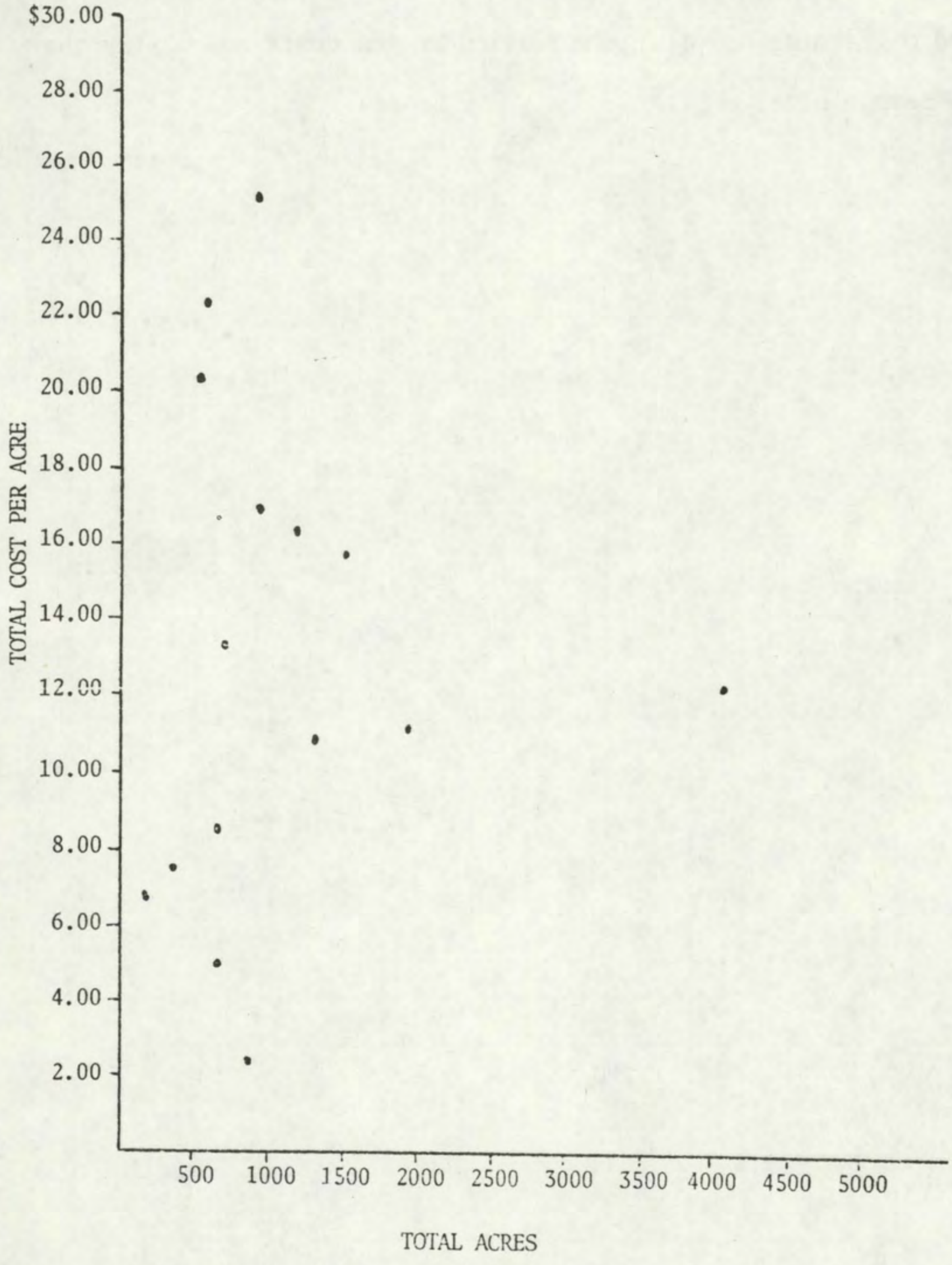

Figure 14. A Scatter Diagram of the Relationship Between Total Cost Per Acre of Machinery and Total Acres for 15 Dryland Farms in Latah County, 1974 Cropyear.

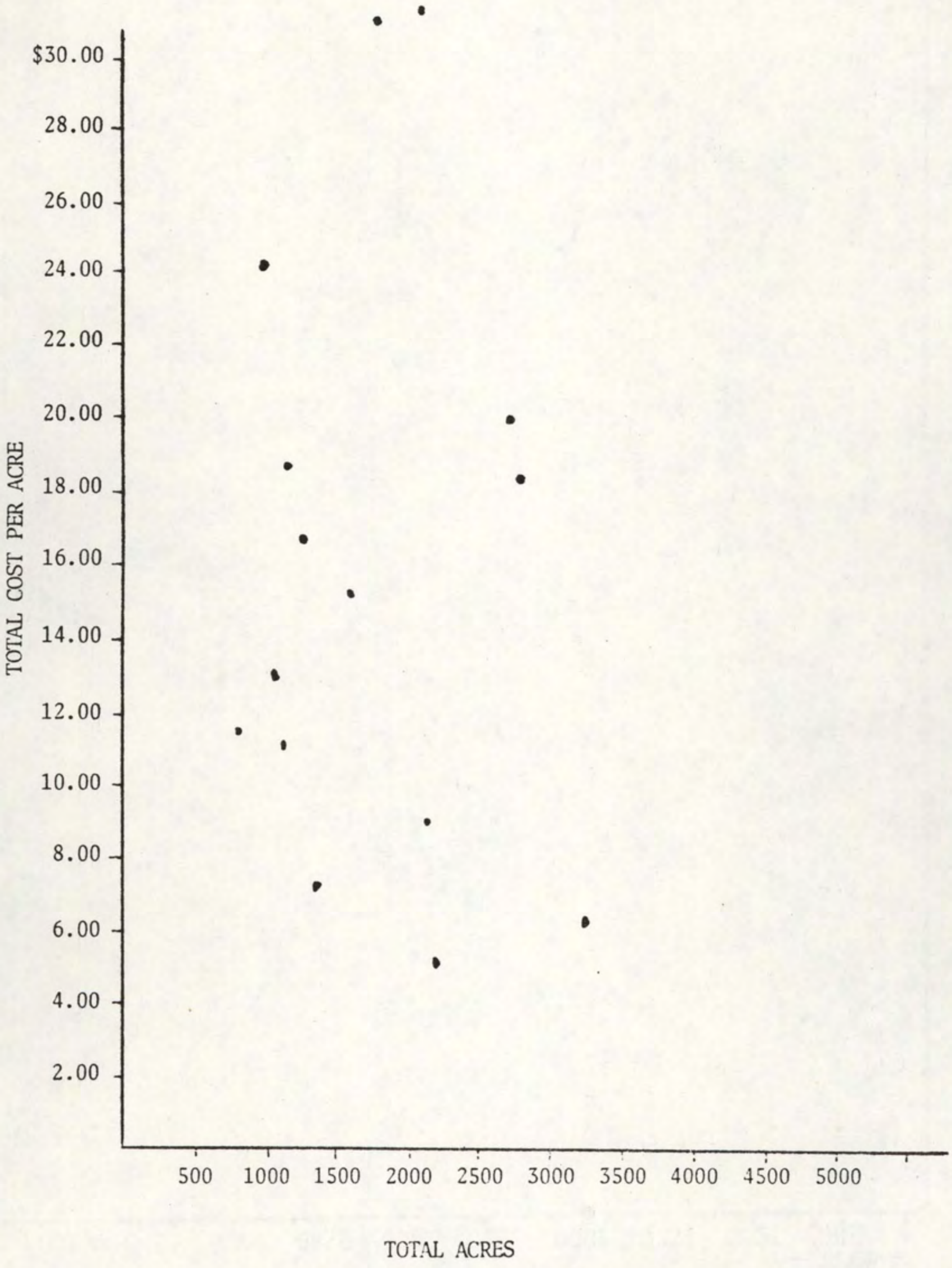

Figure 15. A Scatter Diagram of the Relationship Between Total Cost Per Acre of Machinery and Total Acres for 15 Dryland Farms in Power County, 1974 Cropyear.

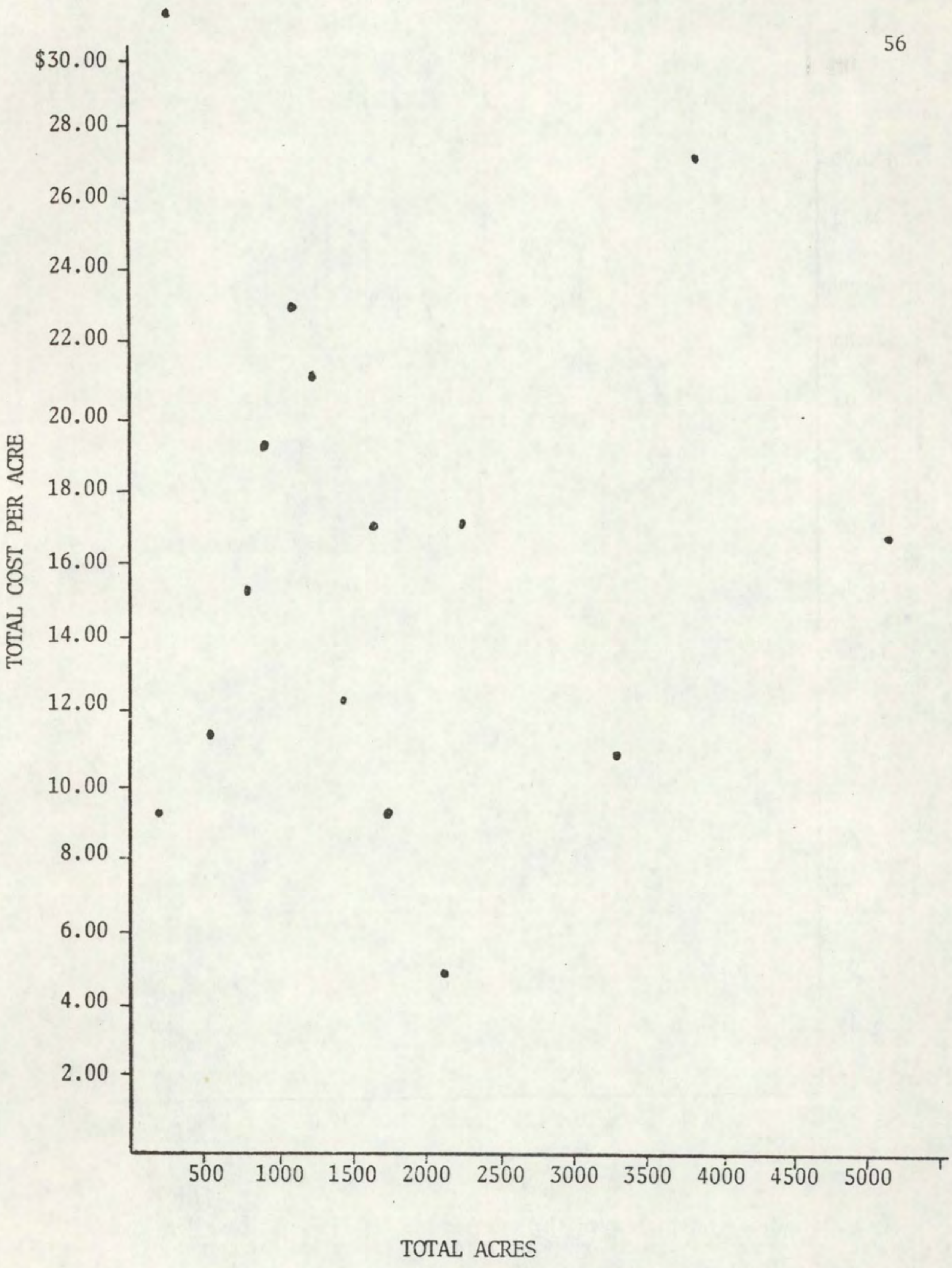

Figure 16. A Scatter Diagram of the Relationship Between Total Cost Per Acre of Machinery and Total Acres for 15 Dryland Farms in Bannock County, 1974 Cropyear.

SUMMARY AND CONCLUSIONS

Summary

With today's rising costs, farmers require information on machinery cost. This study was developed to estimate the unit cost of owning and operating farm machinery for dryland farming in Idaho. The objectives were to develop unit cost curves, to estimate the costs of operating dryland farm machinery, and to aid in replacement decisions.

Forty-eight farmers were interviewed to gather information on cost of owning and operating dryland farm machinery. The cost information included values for taxes, insurance, shelter, interest, depreciation, purchase price, fuel, oil, labor, repair, and maintenance.

Secondary information was taken from the American Society of Agricultural Engineers' yearbook. Regression analysis and a Computer were used to develop total cost-per-hour and total cost-per-acre estimates.

The regression analysis solely used the variable and fixed costs information as reported by the farmers, where as the computer program used formulae taken from the ASAE yearbook and information on purchase price, hourly use, fuel price, and type of fuel received from the farmers surveyed. Regression analysis resulted in cost estimating equations of the form $\frac{1}{y} = a + bX$ for the total cost per hour and the total cost per acre of farms in Latah, Power, and Bannock Counties.

Regression analysis was also used to estimate the total cost per hour for a farm's entire machinery. The resulting equations used the reciprocal of total cost per hour as the dependent variable and total hours of annual use as the independent variable. Latah, Power, and Bannock Counties showed economies of size with similar negative slopes. Power County farms demonstrated the greatest degree of decreasing cost. The total cost per hour for 4,000 hours of annual operation per farm in Power County was approximately $1.70 per hour less than the total hourly cost in Latah and Bannock Counties.

The total cost-per-acre curves were based on the reciprocal of total cost per acre and total acreage. Power and Bannock Counties showed some economies of size. However, in this study, because of the wide variation in total cost per acre, no reliable curves were produced.

Another method of cost estimation utilized a Computer Program. The program estimated the cost per hour for the various types of dryland farm equipment. The Straight Line and Sum-of-the-Years'-Digits depreciation methods were used in the calculation of total cost-per-hour values.

Conclusions

The total cost-per-hour curves indicate that the larger farms in the sample have a definite unit cost advantage in operating dryland farm machinery. Also, information was provided concerning the maximum use a machine should receive before the machine's operating cost starts to increase at which time replacement should be considered.

The natural implication of the conclusion was that as machinery costs rise because of higher fixed and variable costs, it will require larger farms to bear these costs, unless returns per acre also increase.

Managerial ability plays a major role on the reduction of these costs. The cost information and cost curves produced by the computer program may aid the farmer in reducing cost. The curves produced by the computer program indicate that replacement should be considered when the minimum total cost per hour point is reached. However, other factors such as income tax, investment credit, and inflation influence the replacement decision.

The major objectives of the study were fulfilled in the sense that unit cost values and cost curves were developed. However, the majority of the variance in the data received remains unexplained. This unexplained variance was due to the information received from the forty-eight farmers interviewed. The unexplained variance causes a low correlation coefficient between the dependent and independent variables.

Since machinery costs are a major expense on Idaho farms, future researchers should concentrate on improving the accuracy of the cost estimates. Accurate information may be provided by using the farmers' entire total operating cost in the computer program.

The unit cost curves show decreasing costs until a minimum point is reached. Beyond the minimum point, the curves sloped upward due to the rise in repair and maintenance costs. Beyond the minimum total cost per hour, replacement should be considered by the farmer because the cost per hour of retaining the old machine is greater than the cost per hour of purchasing a new machine.

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