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Determination of Optimum Life (Economic Life) for Mf285 Tractor: A Case Study in Center Region of Iran

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Abstract: Making use of tractor to do agricultural mechanized operations is responsible for a fundamental and important role to mechanize agricultural section. Replacement of farm machinery with a new similar machine is one of the most important objects of farm machinery management. Decision making about replacement of used farm equipment with a new similar one is one of the important items in farm machinery management. Proper performance in this case can lead to timely, high quality farm operations which in turns results in considerable decrease in product expenditures and also more income. Based on that the study in order to determine optimum life or economic life for MF285 in west region of Isfahan province was performed. Listed price of tractor, annual depreciation and Internal Rate of Return (I.R.R) in the study period were calculated. These items accompanied by their repair and maintenance cost were used to determine their economic life. Finally replacement time for the study tractor 18316 hours was predicted.

Key word: Economic life % Replacement time % cost % MF285

INTRODUCTION

Today, tractor is one of the most important power sources in agriculture. Effect of tractor power on agriculture is considerable [1]. The use of modern technology during latter decades resulted in rapid growth of farm production. Tractors and farm machinery are important samples of this modern technology [2-4]. The quality of mechanization inputs and consequently land and labor productivity in both situations, may differ considerably [5-7].

Management of farm machinery is one of the important branches of farm management. Deciding considering replacement time of farm machinery noted to conditions of their economical and technological is one of the considered aims in management of farm machinery. A complete line of machinery is one of the largest investments that a farm business can make. Yet, unlike land or buildings, machinery must be constantly monitored, maintained and eventually replaced. How and when equipment is replaced can mean a difference of thousands of dollars in annual production costs.

Deciding for replacing old machinery by new machinery is performed based on its economic life. Economic life, named as optimum life, has a direct relation with repair and maintenance costs. Costs of owning and operating of farm machinery represent 35 to 50% of the costs of agricultural production when excluding the land [8]. The R&M (repair and maintenance cost) is an important item in costs of owning and operation. In general, the costs other than those for R&M usually decrease with increasing usage, but the reverse is true with respect to R&M costs. The cost of R&M is usually about 10% of the total cost; as the machine age increases the cost increases until it becomes the largest cost item of owning and operating of farm machines [9]. Agricultural engineers have done many studies regarding R&M of farm machines. Several studies were conducted in both developed and undeveloped countries either to develop models to determine the cost during a certain period or to get absolute numbers to represent owning and operating certain equipment [10-16]. Based on ASAE, replacement age for a machine that is placed on economic life arrives typically before fundamental breakdowns resulted worn-out and technological disabling [17].

Economic or optimum life for a machine presents a time period based on constant and variable costs that using the machine is economical [18,19]. Each machine has a determined economical life that thereafter using the machine is not economical. It is known that repair and maintenance cost has a large share from machine ownership costs.

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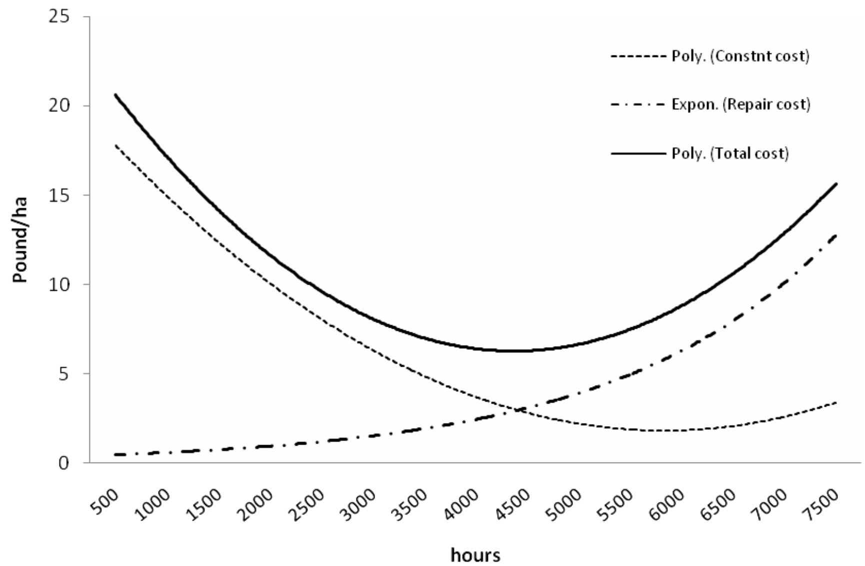

Fig. 1: Curves of total annual machine, constant and variable costs for two wheel drive tractor

As it is shown in Figure 1, while machine age is raised, constant costs is reduced, but repair and maintenance (variable) costs is raised. As it is seen, indication of total annual machine costs is obtained by sum total constant and variable costs. Minimum point of this curve, that is intersection point of constant and variable cost curves, is present as the most appropriate time for replacing machine [13].

The aim of this study is to provide a statically analysis on constant and variable costs for MF285 tractor in order to present the best time for replacing tractor. Determining economical life for farm machinery provides planners and policy makers and also farmers an opportunity to evaluate the performance of machinery economic.

MATERIALS AND METHODS

This study was carried out in Khansar and Golpayegan townships in central region of Iran. Data were collected from 102 MF285 tractor operators in the study region by using a face-to-face questionnaire in the year 2007. Information was sought on tractor characteristics and economic costs such as use of tractor each year, lubrication cost, filter cost, repairman wage, etc. Sample operators were randomly selected from the 32 Villages in the study area by using a stratified random sampling method. The tractors were classified according to their age in unit year into 26 groups from 1 to 26. Therefore, for example, class 4 includes the total tractors four-year-worked.

Machinery costs are divided into two categories, fixed costs and variable costs. Variable costs increase proportionally with the amount of operational use given the machine, while fixed costs are independent of use.

It is not always clear as to which category some of the specific costs belong. The costs of interest on the machinery investment, taxes, housing and insurance are dependent on calendar-year time and are clearly independent of use. The costs of fuel, lubrication, daily service and maintenance, power and labor are clearly cost associated with use. The two remaining cost items, depreciation and the cost of repairing, seem to be functions of both use and time.

Estimations of yearly costs are adequate for determining crop production costs and for deciding if machine ownership is profitable; but the time of replacement decision depends on the accumulated costs over a period of years. Figure 2 compares yearly costs and accumulated costs during the life of a machine. The costs in Fig.2 need to include only depreciation, interest on investment and repair as all other costs are assumed to be independent of the time of replacement.

Depreciation: Declining-balance was used to calculate depreciation for the study tractor. A uniform rate is applied each year to the remaining value (includes salvage value) of the machine at the beginning of the year. The depreciation amount is different for each year of the machine´s life. Equations 1, 2 and 3 express the relationships by formulas.

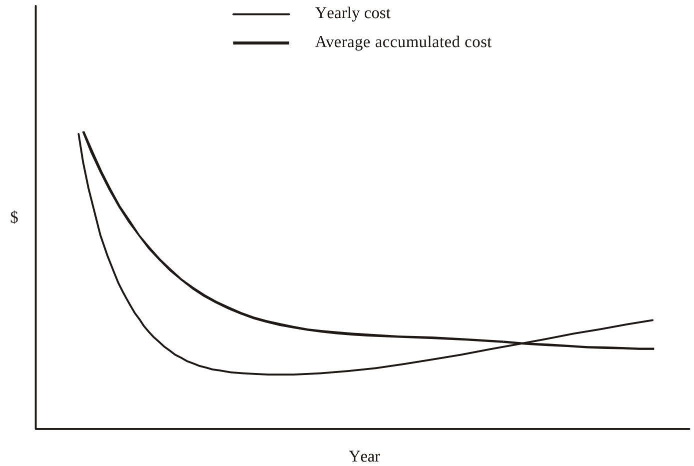

Fig. 2: Average annual and accumulated costs

$$D = V_n - V_{n+1} \quad (1)$$

$$V_n = P\left(1 - \frac{X}{L}\right)^n \quad (2)$$

$$V_{n+1} = P\left(1 - \frac{X}{L}\right)^{n+1} \quad (3)$$

Where: Depreciation, is amount of depreciation charged for year n+1, n, is number representing age of the machine in years at beginning of year in question, V, is remaining value at any time and x, is ratio of depreciation rate used to that of straight-line method (x may have any value between 1 and 2). If x = 2, the method is called a double-declining-balance method and is the maximum rate method permitted by the IRS. For used tractor the rate is x = 1.5.

Interest on Investment: The interest on investment in a farm machine is included in operational cost estimates. Even if the investment money is not actually borrowed, a charge is made since that money cannot be used for some other interest-paying enterprise. Nominal interest rates include expected inflation. In times of substantial monetary inflation, a machinery manager must include the effects of inflation on machinery planning. Inflation causes increased prices for goods and services in future years.

The real interest rate, i_r, is a function of the nominal interest rate, i_n and the rate of inflation, i_i, as shown in Eq. (4).

$$i_r = \frac{i_n - i_i}{1 + i_i} \quad (4)$$

Therefore the interest on investment was calculated by using Eq.(5).

$$i_n = V_n \times i_r \quad (5)$$

whrere, i_n is the interest on investment in n-th year ($) and i_r is the real interest rate.

Repair: Repair costs are the expenditures for parts and labor for, 1: installing replacement parts after a part failure and 2: reconditioning renewable parts as a result of wear. The anticipated annual cost of repair for any one machine is highly uncertain.

To determine time of replacement for the study tractor accumulated depreciation, interest on investment and repair costs were calculated and regression analysis was performed on the data by using the computer software SPSS 12.0 (version 2003).

RESULTS AND DISCUSSION

Accumulated depreciation, interest on investment, repair and total costs for the study tractor is presented in Table 1. One of the difficulties in analyzing machinery costs is that they change over time. Depreciation, often the largest cost of farm machinery, measures the amount by which the values of a machine decrease with the passage of time whether used or not. As it is seen in Table 1 depreciation tends to be great at first, especially for a machine purchased new, but declines over time. Likewise, interest expends is high initially but gradually diminishes. This is true whether the interest cost is cash interest paid on a loam, or an opportunity cost based on revenue foregone by continuing to own a machine year after year. On the other hand, repair costs may amount to little or nothing when a machine is still under warranty,

Table 1: Accumulated costs for Mf285 tractor

Age (year)	Accumulated repair cost(1000$)	Accumulated depreciation cost(1000$)	Accumulated interest on investment cost(1000$)	Total accumulated cost(1000$)
1	4.64	7.84	4.83	17.31
2	10.69	15.09	9.30	35.08
3	16.47	21.79	13.44	51.70
4	22.12	28.00	17.26	67.38
5	28.85	33.73	20.80	83.11
6	85.24	39.04	24.08	98.36
7	42.30	43.95	27.10	113.35
8	49.07	48.49	29.90	127.46
9	57.27	52.69	32.49	142.46
10	65.48	59.58	34.89	156.95
11	73.75	60.17	37.11	171.03
12	81.16	63.50	39.16	183.81
13	89.46	66.57	41.05	197.09
14	97.26	69.42	42.81	209.48
15	104.80	72.05	44.43	221.28
16	114.63	74.48	45.93	235.04
17	124.99	76.73	47.32	249.04
18	135.76	78.82	48.60	263.18
19	145.96	80.74	49.79	276.50
20	157.00	82.52	50.89	290.41
21	169.40	84.17	51.91	305.41
22	182.03	85.70	52.85	320.58
23	169.57	87.11	53.72	337.24
24	210.24	88.42	54.52	353.18
25	222.88	89.62	55.26	367.77
26	236.65	90.74	55.95	383.35

Table 2: Operating hours and cost for MF285 tractor

Age (year)	Annual operating hours	Accumulate operating hours	Average accumulated cost ($/h)	Average annual cost ($/h)
1	796.23	796.23	21.74	21.74
2	942.25	1738.48	20.18	18.86
3	1015.32	2753.78	18.77	18.37
4	790.25	3544.03	19.01	19.84
5	1137.37	4681.41	17.75	13.82
6	762.6	5464.20	18.00	19.48
7	993.88	6457.88	17.55	15.08
8	825.5	7283.38	17.50	17.09
9	903.66	8187.04	17.4	16.56
10	869.44	9056.48	17.33	16.67
11	1049.25	10106.14	16.92	13.41
12	745.25	10851.39	16.93	17.15
13	936.74	11788.13	16.72	14.17
14	884.52	12674.63	16.53	14.04
15	967.54	13640.17	16.22	12.19
16	886.75	14526.92	16.18	15.52
17	862.52	15389.42	16.18	16.23
18	1099.20	16488.62	15.96	12.87
19	925.75	17414.37	15.88	14.38
20	902.25	18316.62	15.85	15.43
21	865.36	19181.98	15.92	17.40
22	962.52	20144.48	15.91	15.69
23	964.71	21111.48	15.98	17.39
24	834.25	21946.43	15.09	18.90
25	910.25	22856.68	16.09	16.03
26	1047.50	23904.18	16.04	14.87

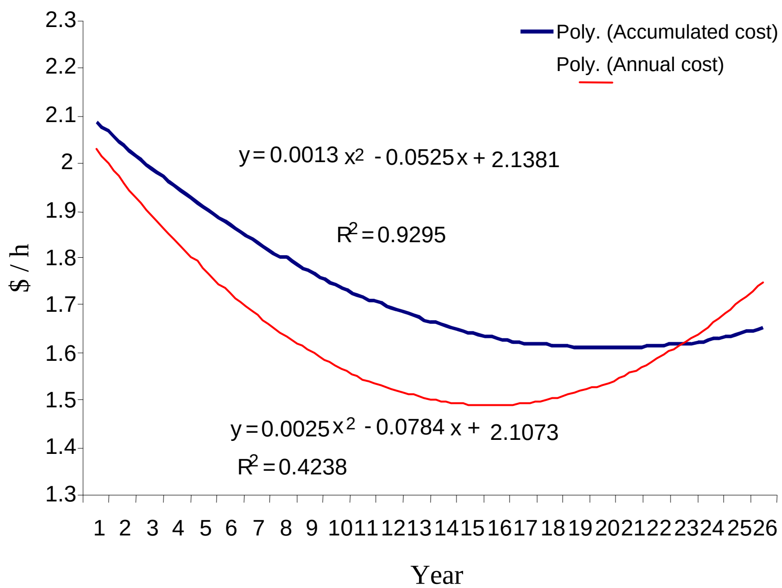

Fig. 3: Average annual and accumulated costs for MF285 tractor

but eventually increase as parts wear out and maintenance requirement rise.

Accumulate and annual operating hours and also average annual and total costs are presented in Table 2. As it is seen in the table, average accumulated costs in 20th year drop to their lowest value. Figure 3 presents the accumulated costs through an equation of polynomial with a correlation coefficient R^2 = 0.93 and yearly costs through an equation of polynomial with a correlation coefficient R^2 = 0.42for MF 285 tractor.

As it is shown in the figure, the first year´s costs are high because of the very real marketplace depreciation obtained from the estimate value method. The yearly costs drop to their lowest value (20 th year) and then begin to rise if the annual repair costs increase with age. The accumulate cost curve drops more gradually and levels out at the point where it crosses the yearly cost curve.

The standard rule for minimizing the long-run cost of equipment is to make a change when the annualized total cost of owning and operating the machine begins to increase. In the study, this happens in about the 20th year of ownership. At this point repair costs begin to increase faster than depreciation and interest costs decrease. However, the rate at which total costs rise is often very gradual.

Thus, while the rule of increasing total cost can give a general picture of when to replace a particular machine, it cannot give a precise answer. Note that the estimates for repair costs project them to increase gradually over time. In reality, though, repair costs tend to be quite variable from year to year, ranging from only routine maintenance items to a complete overhaul. Being able to anticipate when large repair costs will be needed is a key consideration in deciding when to replace a machine.

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