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# Determining replacement age of agricultural tractor (JD3140) in Varamin Region (case study)

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**One of the main aims in the management of farm equipment and tractors is to decide their replacement, based on technical and economic conditions. The objective of this research was to determine the economic life time for John Deer3140, common in the Varamin Region of Iran. First the annual depreciation and interest were calculated considering the initial purchase price of tractor, and then the economic life was calculated based on repair and maintenance costs. Based on the results, the most suitable replacement age was obtained, which was eight years for John Deer 3140.**

**Key words:** Economic life, replacement age, JD3140, Varamin Region.

## INTRODUCTION

Agricultural tractors are the most common sources of power generating in the present mechanized agricultural operations. One of the aims in agricultural machinery management is to decide on making the replacement of tractors considering the technical and economical conditions of the region which are used. Proper application and appropriate decisions about timely replacement of tractors and equipment makes agricultural operations to be done in time with good quality and consequently results in lower costs and higher revenue. In Iran, tractors are even used by farmers for some more years after their economic life and they do not have replacement issue, because the repair and maintenance costs are not calculated properly and the timeliness costs are not considered in the agricultural section. It is clear that the breakdown cases will be increased after the economic life of the tractors while many of them may not be predicted, so the delay rate will be very high. On the other hand, fuel consumption will be increased after economic life. Making decision about the replacement of aged machines is based on the economic life. Economic life, which is also known as useful life, is usually shorter than the machine's life and it depends on the repair and maintenance costs of the machine. In general, the total

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costs of a machine are divided into fixed and variable costs. With increase in the operating hours of the machine, the fixed costs including depreciation and interest have a declining trend per operation unit (area or time), while the variable costs including repair and maintenance will be increased. The optimum time for replacing is when the total accumulated costs per operation will be low and after that will be increased again (ASAE Standards, 2000a). Varamin is a region in Southeast of Tehran. The main aim of this research is to evaluate the operational conditions for more use of tractor in this region, namely John Deer 3140, in order to find the best replacement age for it.

## MATERIALS AND METHODS

The data and information for ten JD3140 (95hp) tractors in Varamin (15 Km Southeast of Tehran) were collected and examined over 10 years. The collected data included repair and maintenance costs, annual operating time, as well as purchase price. The price of JD3140 is listed as 15000 $, based on the official statistics of the Agricultural Machinery Development Agency, and the inflation rates posted by the central bank in 2008. Repair and maintenance costs were roughly calculated by referring to the owners and considering the costs of spare parts, used materials, and repair fee and then a questionnaire was completed for tractor. The annual operating hours were determined based on the tractor working hour counter.

### Depreciation

The declining balance method (reduction with fixed percent) was used for calculation of depreciation based on Equations (1) and (2) (ASAE Standards, 2000b).

$$V_n = P\,(1-x/l)^n \quad (1)$$

$$D_n = V - V_{n+1} \quad (2)$$

In which $D_n$ is depreciation rate in the year of calculation, n is machine's age in the year of calculation, $V_n$ is the remaining value of the machine at the end of the $n^{th}$ year ($), x is depreciation ratio (1<x<2), l is total machine life (year) and P is purchase price ($).

In the computations, x is designated a mean value of 1.5 and l equals to 10 years Equation (1).

### Interest

Equation 3 was used for calculation of interest (ASAE Standards, 2000a).

$$I_n = V_n \,.\, I \quad (3)$$

In which $I_n$ is interest in the $n^{th}$ year ($), i is interest rate based on central bank rate in 2008 (i=15%).

### Replacement determination method

Following the calculation of repair and maintenance costs and operating hours over 10 years as well as depreciation and interest over the same period, the economic life of the tractors was calculated as follows. First, depreciation and interest costs, known as capital costs, were calculated. Total accumulated cost was calculated through adding accumulated repair and maintenance and accumulated capital costs. Total accumulated cost per operating unit was obtained by dividing the total accumulated cost by the accumulated operating hours. In this study, operation time is assumed as the operating unit. Economically, the optimum time for replacement of the machine is when the minimum total accumulated cost per operating unit occurs (Cross, 1998).

## RESULTS

### Depreciation and interest

Table 1 and Figure 1 show the depreciation rate, interest rate, annual interest, and annual interest added depreciation as well as accumulated capital costs for JD3140 tractor in the first 10 years of the tractor's life. It is obvious that annual capital costs are reduced with time.

### Repair and maintenance, capital and total accumulated costs

Table 2 and Figure 2 show the costs of spare parts, repairs, oil and filter costs, total repair and maintenance costs in that year as well as the total accumulated repair and maintenance costs as rates and percentages.

Accumulated repair and maintenance, accumulated capital and total accumulated costs per year for the tractor is shown in Table 3. In this table, the total accumulated cost in each year was obtained by sum of the total accumulated repair and maintenance costs and accumulated capital costs of that year.

### Total accumulated, accumulated operating and total costs per operating hour

Based on the results shown in Table 1, the annual capital costs including depreciation costs and annual investment interest decrease year by year. These costs have no direct relationship with the usage rate during machine life but somehow they are affected by them. Usage of machines causes less depreciation costs and investment interest, because a certain portion of annual costs will be divided into more operating hours (Ward et al., 1985).

**Table 1.** Depreciation, interest and capital costs for JD3140 tractor.

| Year | Annual depreciation costs(100$) | Annual interest of investment (100$) | Annual capital costs (100$) | Accumulated capital costs (100$) |
|---|---|---|---|---|
| 1 | 22.5 | 19.12 | 41.62 | 41.62 |
| 2 | 19.12 | 16.25 | 35.37 | 76.99 |
| 3 | 16.26 | 13.81 | 30.07 | 107.06 |
| 4 | 13.82 | 11.74 | 25.56 | 132.62 |
| 5 | 11.75 | 9.98 | 21.73 | 154.35 |
| 6 | 9.95 | 8.49 | 18.44 | 172.79 |
| 7 | 8.5 | 7.21 | 15.71 | 188.5 |
| 8 | 7.2 | 6.13 | 13.33 | 201.83 |
| 9 | 6.2 | 5.20 | 11.4 | 213.23 |
| 10 | 5.27 | 4.42 | 9.69 | 222.92 |

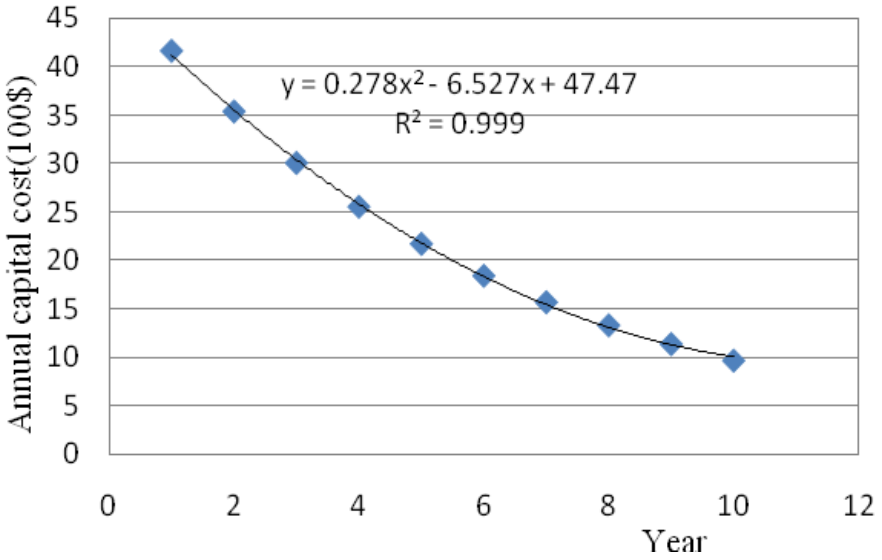


**Figure 1.** Depreciation and interest costs per year for JD 3140 tractor.

Table 2 shows the repair and maintenance costs for JD3140. These costs depend on the operation time of the machine. Higher usage of the machine results in repair and maintenance costs. The table also shows an increase in repair and maintenance, spar part, and oil costs. The percentage of each item is different in different years and it may be higher or lower than the past or next year but in calculation the sum of repair and maintenance costs is important; it increases in time. Higher costs of spare parts may be caused by low quality of the parts, overuse or early replacement of the spare parts, improper usage of tractor caused by insufficiently trained drivers, non-standard parts, improper repair and more importantly excessive use after the economic life of the tractors is exceeded.

## DISCUSSION

Based on the data in Table 4 and Figure 3, the total accumulated costs per operating hour was calculated by dividing the total accumulated costs and accumulated operating hours. In the table, the total accumulated costs per operating hour decrease first and then increase after the eighth year for JD3140. Hence, the best time for replacement is when the total accumulated costs per

**Table 2.** Repair and maintenance costs for JD 3140 tractor over 10 years.

| Year | Spare parts | | Repairs | | Oil and filter | | Total repair and maintenance costs in year | Total accumulated repair and maintenance costs |
|---|---|---|---|---|---|---|---|---|
| | Rate (100$) | Percent | Rate (100$) | Percent | Rate (100$) | Percent | | |
| 1 | 1.882 | 45.68 | 1.614 | 39.19 | 0.623 | 15.13 | 4.12 | 4.12 |
| 2 | 2.687 | 46.66 | 2.257 | 39.20 | 0.814 | 14.14 | 5.76 | 9.88 |
| 3 | 2.90 | 46.4 | 2.392 | 38.28 | 0.957 | 15.32 | 6.25 | 16.13 |
| 4 | 7.329 | 44.34 | 6.4 | 38.72 | 2.8 | 16.94 | 16.53 | 32.66 |
| 5 | 11.035 | 46.86 | 8.393 | 35.64 | 4.121 | 17.50 | 23.55 | 56.21 |
| 6 | 14.295 | 45.34 | 11.71 | 37.14 | 5.524 | 17.52 | 31.53 | 87.74 |
| 7 | 16.076 | 45.62 | 13.754 | 39.02 | 5.539 | 15.35 | 35.24 | 122.98 |
| 8 | 19.524 | 47.90 | 15.668 | 38.44 | 5.867 | 13.66 | 40.76 | 163.74 |
| 9 | 29.803 | 46.81 | 25.105 | 39.43 | 8.76 | 13.76 | 63.67 | 227.41 |
| 10 | 28.737 | 44.79 | 23.950 | 37.33 | 11.471 | 17.88 | 64.16 | 291.57 |
| Mean | | **46.04** | | **38.24** | | **15.72** | | |

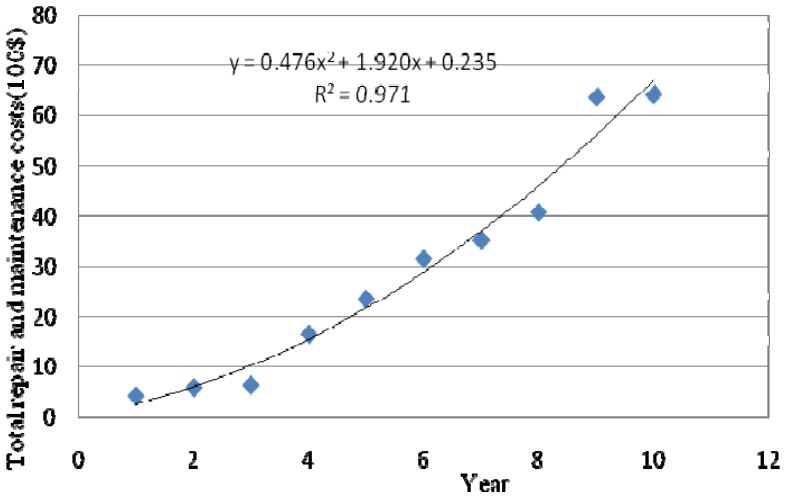


**Figure 2.** Total repair and maintenance costs for JD3140 in year.

operating hour are minimum after which costs rise again (Hunt, 2001; Ward et al., 1985).

It maybe concluded that the best age of replacement for JD3140 is at the end of eight year. According to the available information in mechanization development center of Iran in 2002, the actual mean useful life for tractors in Iran is considered to be about 13 years while unofficial reports show higher levels. Obviously, there is a significant difference between economic life of tractors and their true and operational function. When the repair and maintenance cost of this tractor is not calculated properly, the true level of costs is not clear to use for replacement decisions and in most cases continued use of old tractors is not economical. The time of agricultural proactive and timeliness costs are still overlooked in Iran especially in small farms. It is known that when the economic life of a tractor is exceeded, breakdown cases increase and down time delay will be high, whereas timely replacement can prevent these losses. The important aspects for increasing the economic life of tractors are timely servicing, repairs and maintenance, using good quality spare parts and materials and proper

**Table 3.** Repair and maintenance, capital, and total accumulated costs for JD3140 tractor.

| Year | Accumulated repair and maintenance costs (100$) | Accumulated capital costs (100$) | Total of accumulated costs (100$) |
|---|---|---|---|
| 1 | 4.12 | 41.62 | 45.74 |
| 2 | 9.88 | 76.99 | 86.87 |
| 3 | 16.13 | 107.06 | 123.19 |
| 4 | 32.66 | 132.62 | 165.28 |
| 5 | 56.21 | 154.35 | 210.56 |
| 6 | 87.74 | 172.79 | 260.53 |
| 7 | 122.98 | 188.5 | 311.48 |
| 8 | 163.74 | 201.83 | 365.57 |
| 9 | 227.41 | 213.23 | 440.64 |
| 10 | 291.57 | 222.92 | 514.49 |

**Table 4.** Accumulated, accumulated operating and total costs per operating hour for JD 3140 tractor.

| Year | Total accumulated costs (100$) | Annual operating (100$) | Accumulated operating (100$) | Total accumulated costs per operating hour (100$) |
|---|---|---|---|---|
| 1 | 45.74 | 1151 | 1151 | 39.73 |
| 2 | 86.87 | 1249 | 2400 | 36.19 |
| 3 | 123.19 | 1027 | 3427 | 35.94 |
| 4 | 165.28 | 1250 | 4677 | 35.33 |
| 5 | 210.56 | 1340 | 6017 | 34.99 |
| 6 | 260.53 | 1460 | 7477 | 34.84 |
| 7 | 311.48 | 1560 | 9037 | 34.46 |
| 8 | 365.57 | **1670** | **10707** | **34.14** |
| 9 | 440.64 | 1540 | 12247 | 35.97 |
| 10 | 514.49 | 1580 | 13827 | 37.20 |

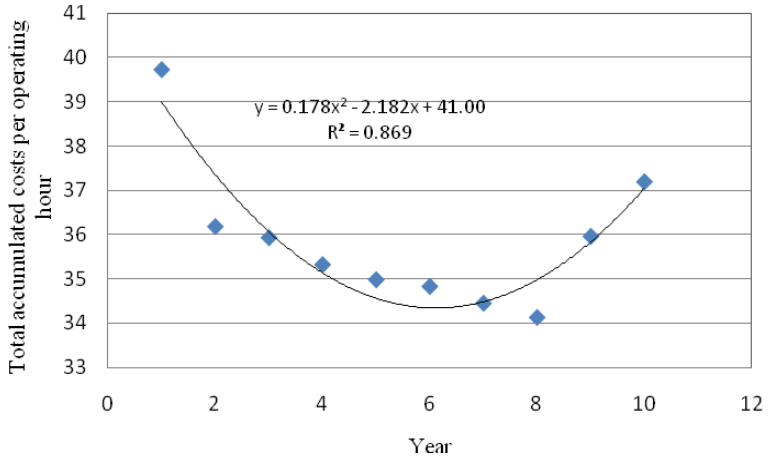


**Figure 3.** Total accumulated costs variations per operating hour for JD3140 tractor in time.

training of drivers. It is suggested to perform similar studies in different regions having different operational, climatic, economical and management conditions to determine the best time for replacement of tractor in that region. This process requires a system for collecting and recording data on operating hours, repair and maintenance costs, and calculating depreciation, interest and timeliness costs.

## Conflict of Interests

The author(s) have not declared any conflict of interests.

## ACKNOWLEDGMENT

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## REFERENCES

ASAE Standards (2000a). D497.4: Agricultural Machinery Management Data.

ASAE Standards (2000b). EP496. Agricultural Machinery Management.

Cross T (1998). Machinery Cost Calculation Methods. Agricultural Extension Service. The University of Tennessee Institute of Agriculture. USA.

Hunt DR (2001). Farm Power and Machinery Management. Tenth Edition. Iowa State University Press. Ames. U.S.A.

Ward SM, Mc Nulty PB, Cunney MB (1985). Repair Costs of 2 and 4 WD Tractors. Transactions of ASAE. 28(4):1074-1076. http://dx.doi.org/10.13031/2013.32390