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## Technical and Economic Features of Tractors in the Second Hand Market in Sanliurfa Province

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### Abstract

In this study, it was aimed to determine various parameters of tractor use in agricultural production in Şanlıurfa province and the tendency of the farmers in the region towards tractor use by analyzing the collected data and obtaining generalizable results. In this context, an information gathering form was prepared to determine the technical and economic characteristics of tractors in the second-hand tractor market. The 450 information gathering forms were filled in face to face with the tractor dealers in the province, the dealer (broker) trading tractors and the vendors in the tractor market. The collected data were analyzed with the help of different statistical analysis programs. According to the results, the average rated engine power for tractors in the second hand market was determined as 57 kW. In addition, the average annual usage time of tractors in the second-hand market has been determined as 432.8 h, and other operating parameters related to the use of tractors include age, rated engine power, engine, gearbox, hydraulic system, cabin/hood and tires, and average annual usage. duration, estimated selling price, depreciation characteristics, etc. parameters were determined for tractors and the obtained data were evaluated by multiple regression analysis and the results were examined.

**Keywords:** Tractor, Operating parameters, Agricultural mechanization level, Sanliurfa

### Introduction

The use of tractors in agricultural enterprises is an issue that needs to be examined in technical and economical terms. Scientific approach in making decisions about the tractor is a requirement of a rational management. Because, tractor investment has an important place in the fixed investment expenditures made in the enterprise. On the other hand, the part stemming from the tractor constitutes the leading part of the operating expenses. For these reasons, it is necessary to determine the operating parameters related to the use of tractors in order to make correct investment and management decisions.

Operating parameters of tractors related to use include age, rated engine power, engine power per unit area, loading

rate, fuel and oil consumption, maintenance and repair costs, condition of engine-gearbox-hydraulic system-cabin/bodywork and tires, average annual service life, market value, depreciation characteristics, scrap value etc. parameters can be counted (Bowers 1975, Witney 1988b, Hunt 2001, Basol 2006). The values of these parameters may vary depending on the business and the user. The process, which initially started with the decision to choose suitable tractors for the business, ends in many different ways depending on the usage characteristics. From this point of view, determining the usage characteristics of tractors is important in terms of the appropriateness of the selection and the operational performance.

The aim of this study is to examine the various parameters of tractor use in agricultural production in Sanliurfa-Harran

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region (age, rated engine power, engine, gearbox, hydraulic system, cabin/hood and tire condition, average annual usage time, estimated sales price, depreciation characteristics, etc.) obtains generalizable results by determining and analyzing the data collected for tractors. In this way, it is aimed to determine the tendency of the farmers in the region towards tractor use.

## Material and Method

### Material

The research material consists of the tractors found in the tractor dealers in Sanliurfa Province and its districts and in galleries (brokers) that trade and exchange tractors. In order to reach the determined sample size, data of 450 tractors in total, which are offered for sale in 31 separate galleries, have been compiled. The general agricultural production characteristics of Sanliurfa and its districts and the general soil structure of the districts, climate characteristics, the use of agricultural land, agricultural products production, business size and land distribution determine the types of tractors preferred in the plain.

### Method

#### Method used to determine the sample size

An information gathering form was prepared to determine the technical and economic characteristics of tractors in the used tractor market. The 450 information gathering practices consisting of 20 questions were carried out by meeting face to face with the tractor dealers in the province, the dealer (broker) trading tractors and the vendors in the tractor market. An information gathering form was filled in for each tractor subject to sale in the market.

#### Conducting interviews and information gathering method

The questions in the information collection form used in the second hand tractor market research were prepared for the purpose of determining the current situation in the region in accordance with the purpose of the research. Some of the questions in the information collection form reflect the views of the authorized person interviewed on the issue. These questions were answered in line with the personal opinion of the authorized person and the general structure of the used tractor market. Before preparing the information gathering form, information about the general, technical and economic characteristics of tractors was reviewed. Particular attention was paid to selecting the most prominent and relevant questions on the subject. Some of the questions in the form include the date of the interview, the place where the interview was held, the address information of the interviewee and the company. Most of the questions in the form are related to the technical and economic characteristics of the tractor. These are engine, cabin-hood, gearbox, hydraulic system and tire condition.

#### Methods used in data analysis

The questions in the information collection forms showing the technical and economic characteristics of tractors were filled out separately for each tractor. The information collection forms obtained as a result of the research were grouped and numbered primarily on the basis of districts. The answers to the questions in the information collection forms were processed in a workbook created in the Microsoft Excel program. The

data obtained were analyzed with the help of various statistical analysis programs (SPSS, MINITAB).

Regression relations between variables were determined by creating means, proportional values and tables with the data obtained by evaluating the answers to the questions in the information collection forms. The data classified on the basis of two or more characteristics of the tractors within the scope of the study were evaluated. Accordingly, the degree of affinity between two or more tractors of tractors was determined. By applying statistical analysis to these variables, the model giving the highest degree relation was determined.

Later, in determining the relationship between the estimated sales price of tractors in the second-hand market and other variables, the LIMDEP package program was used for model approaches based on data transformations, tabulation, linear and nonlinear regression analysis (Gül et al. 2001). In the multiple regression analysis model used within the scope of the program, the estimated sales price (ESP) parameters for the tractors in the second hand market were used as the dependent variable.

Tractor brands (New Holland, Uzel (MF), Türk Traktör (FIAT) and Ford), tractor age, number of cylinders, rated engine power, total service life, engine condition, engine revision, cabin-bodywork condition, gearbox-differential, the parameters related to the hydraulic system and tire conditions were included as independent variables in the models. By correcting the variation of error terms in the model, each observation has the feature of having equal variation.

The following formula was used for calculating the elasticity coefficients of the variables in the developed linear models (Cinemre and Ceyhan 1998).

$$e = \frac{\partial Y}{\partial X} * \frac{\bar{X}}{\bar{Y}} \dots\dots\dots(1)$$

where,

e: Elasticity coefficient is used to calculate what percentage change in the independent variable creates a percentage change on the dependent variables of supply or demand (Anonymous, 2002),

$\frac{\partial Y}{\partial X}$  : First order derivative of the dependent variable with respect to X (coefficient of X),

$\bar{X}$  : Average value of the explanatory variable,

$\bar{Y}$  : Shows the average value of the dependent variable.

In order to achieve meaningful results in this model, the elasticity coefficients were determined and evaluated in order to reveal the percentage change on the tractor purchase price (TPP), which is the dependent variable of the other independent variables (AGE, TUT and REP), which are not only dummy variables (expressed as unit 1 or zero).

## Results and Discussion

Among the technical features of the tractors subject to research, the characteristics of the traction condition come first. The 87% of the second hand tractors offered for sale in

the market consist of standard structured tractors called single wheel drive. Double wheel drive tractors have a proportional share of 13%. This situation encountered can be said that the enterprises in the plain have turned to the use of double-wheel drive tractors with the polyculture product pattern implemented with irrigation.

The 91% of the tractors in the second hand market have 4 cylinders. Here, it is observed that the number of cylinders of medium power tractors (50-65 kW), which is the dominant group, stands out.

One of the most important operating parameters that come to the fore in researches on tractors is the duration of use. Because the operating time of the tractor directly affects the

operating costs. In Figure 1, the total service life (TSL) values of the tractors in the second hand market with reliable data are given depending on the age. The linear equation obtained as a result of the regression analysis was placed on the scatter plot of the data.

A probability level of  $p < 0.0001$  was determined with a coefficient of indication of  $R^2 = 0.477$  in the linear model between the age and TSL parameters for tractors in the second hand market. The equation for the linear model is  $y = 432.8 * x$ . From the first derivative of the regression equation obtained, the annual average usage time can be calculated as 432.8 h (Figure 1).

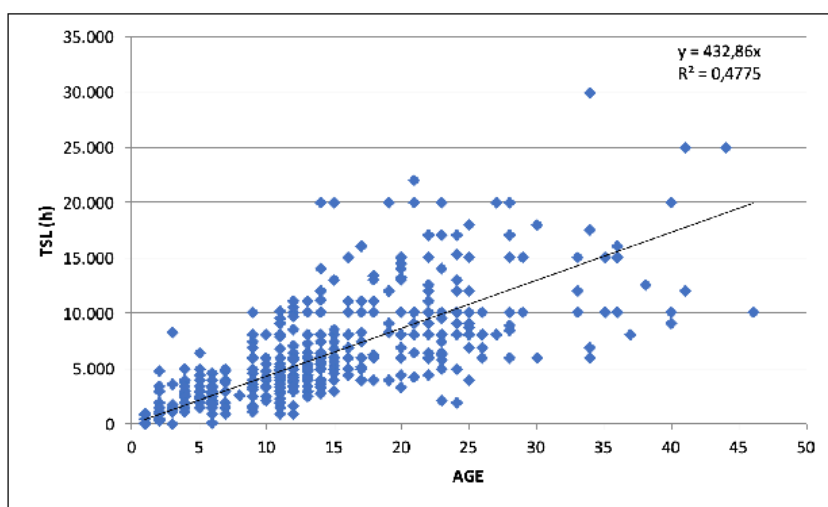


Figure 1. The change between tractor age and total service life (TSL) in the used tractor market

The graph shown in Figure 2 is obtained by taking the average of the total usage periods of tractors of the same age from the data in Figure 1. It has been determined that the observation values in the graph are suitable for a model

(cubic model) that can be expressed with a third order equation with the coefficient of determination of  $R^2 = 0.7876$  at the probability level of  $p < 0.0001$ . The equation of the determined model is;  $y = 0.0537x^3 - 8.0937x^2 + 596.45x - 65.509$ .

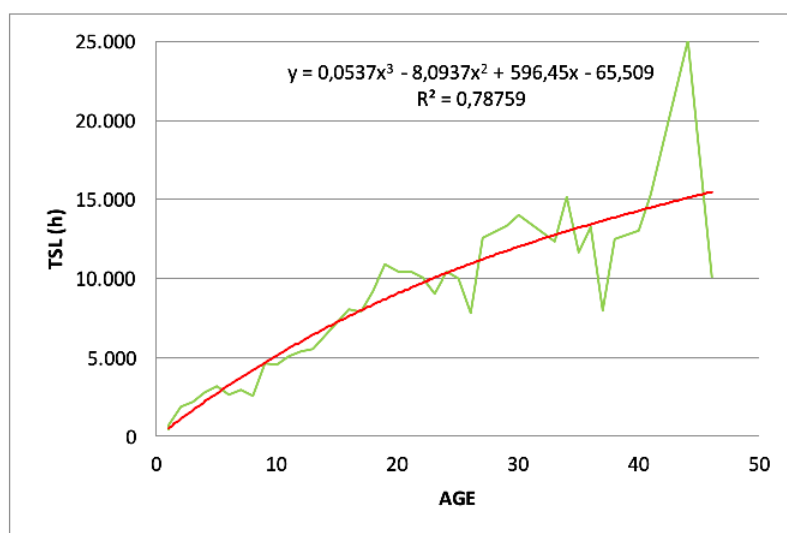


Figure 2. Change of age and total usage time values obtained according to average values

The average annual usage time of tractors in the second hand market is 432.8 hours. These values are based on the average annual usage time of tractors (365 h/year) determined for Harran District in the study conducted by Isik (1998) in Sanliurfa-Harran Plain, and the average annual usage time determined by Sumer et al. (2008) for used tractors in Canakkale (377 hours/year) and Akinci and Canakci (2000) for the enterprises with the highest number of enterprises in the Antalya region with a land size of 5.1-10 ha values found for tractors and some in Business Administration (550.6 h/year) again, given robust and Akdemir in the literature (2002) by the average annual usage period set for Turkey's north west (479.32 h/year) high and tractors in the second hand market. The values found for (432.8 h/year) are lower than the values in the same literature.

Considering the literature information such that the hourly total costs of tractors decrease with the increase of annual usage time, hourly tractor costs are lower for enterprises with large production areas (Henderson and Fanash 1984) and the tractor usage time should be over 800 hours economically (Sara1982), at least 650 h/year should be used and that the usage between 850-1000 h/year is the range where the tractor is used effectively (Demirci 1986), it is seen that the tractor usage time is quite low under the conditions of the Harran Plain.

The most important technical parameter of agricultural tractors is the rated engine power. This value significantly affects the machine size and operating costs that the tractor can operate. The rated engine power of tractors encountered in businesses varied between 40 kW and 86 kW. The rated engine power of tractors encountered in the second hand market varied between 35 kW and 89 kW. Examining the tractors in the used tractor market, it is understood that the power distribution is

in the 50-65 kW range, which can be described as the medium power group.

It can be said that the proportional increase in the amount of tractors for sale with a nominal engine power of 50-55 kW in the second-hand market depends on the lack of power. With the widespread use of irrigated agriculture in the Harran Plain, it is observed that the tractors and the equipment operated with them have diversified and their capacities have increased in parallel with the applied product pattern and the tractors with a rated engine power below 45 kW are decreasing in the region. Accordingly, it is observed that there is an increase in the use of high powered tractors. In the example taken from the second hand tractor market, the average rated engine power value of all tractors was calculated as 57 kW.

However, the average tractor power for Turkey was 44 kW according to Agricultural Machinery and Equipment Manufacturers Association (TARMAKBIR) report for 2007 (Anonymous 2007). Sabanci et al. (2003a) Evcim et al. (2010) reported it as 43,6 kW and 43 kW, respectively. According to these values, the average power determined to track tractors scope of work in the second hand market (57 kW) seems higher than the average in Turkey. However, it is lower than the average tractor engine power (74 kW) determined for EU countries (Anonymous, 2007).

In order to determine the average annual service life of tractors in the second hand market, the total usage time (TUT) value was proportioned to the tractor age (AGE). The data obtained are given in Figure 3 depending on the rated engine power. The results of both the shape examination and the statistical analysis revealed that the average annual usage time is independent of the rated engine power for tractors in the second hand market.

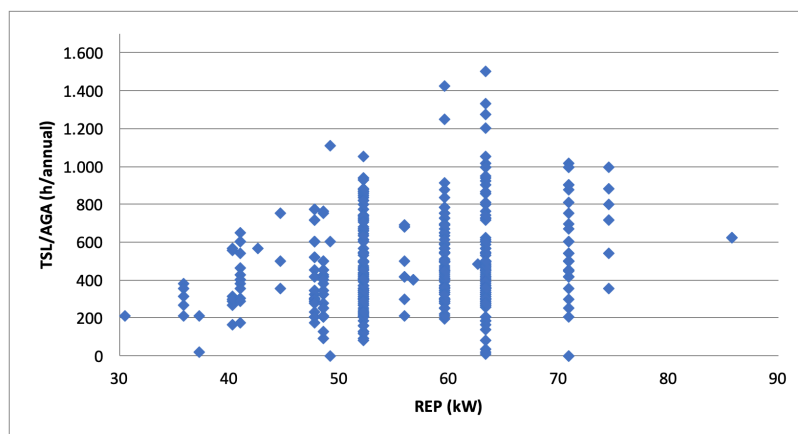


Figure 3. Variation of the average annual service life of tractors in the second hand market depending on the rated engine power (REP)

The 30% of the total tractors evaluated within the scope of the study are tractors that have not undergone engine revision before (0 revision number). Considering that the average age of the tractors in the example is approximately 15, it is seen that the remaining tractors have undergone at least one engine overhaul. On the other hand, by examining the number of revisions depending on age, it is seen that there is no tractor that underwent revision before the age of 8. In the 8-10 age

range, it is observed that the first or the second engine revision took place. Tractors between the ages of 10-18 have at least 1 engine revision, and this number can go up to 5. If the age of 18 and over is, the average number of engine revisions is 2.6 per tractor.

It is noteworthy that the engine, gearbox and hydraulic system repair requirements of tractors in the used market show age-related repetitive changes. This situation, which shows

periodic changes, is thought to stem from the use and the importance of these three organs for the tractor. In other words, it is absolutely necessary to eliminate the malfunctions of these organs in terms of the tractor's function.

However, the change obtained in terms of the cabin/body repair requirement is different from these. This need for repair arises both at a later age and is considered to be a delayed repair requirement from the farmer's perspective. We have the impression that the reason for the proportional highness of 28-year-old tractors in the second-hand market in terms of the need for cabin/hood repair is due to the fact that for the first time such a requirement arises at the mentioned age is a result of the said delay. While there are periodic renewals that can be encountered at an early age due to use in the tire

renewal requirement of tractors in the used tractor market, a proportional increase at the age of 14 and 22 is noteworthy. The reason for this is thought to be due to the general aging of the tractor.

Since the tractors encountered in the second hand market have not been sold yet, the monetary values demanded by the sellers have been named as the estimated sales price and used in order to determine the value of the tractor. In determining the estimated sales price, the opinions of the experts of the organizations operating in the market were also used. Figure 4a and 4b shows the distribution of estimated sales price (ESP) values depending on the model year of the tractors in the example. Figure 5 shows the distribution of estimated sales price values depending on the age of the tractor.

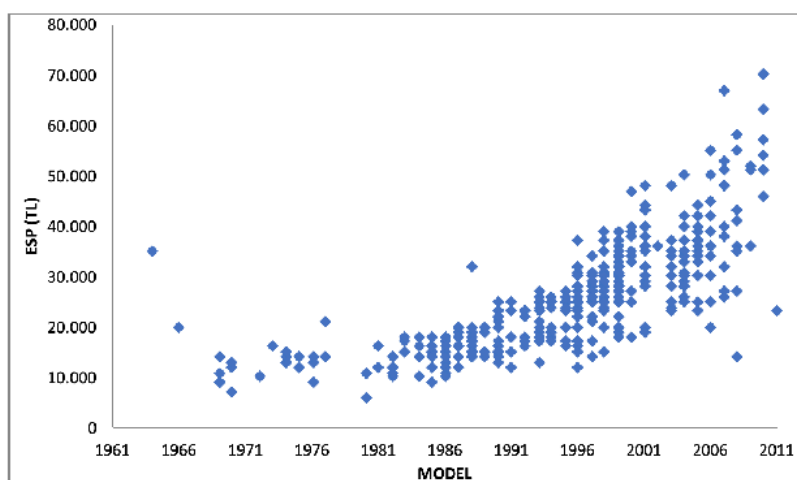


Figure 4a. The change of the estimated sales price (ESP) of tractors in the second-hand market depending on the model year.

As a result of the analyzes made by taking the average for the purpose of modeling the distribution, it was determined that the age-related estimated sales price values correspond to a third order (cubic) function at a high degree ( $R^2 = 0.961$ ) and at the probability level of  $p < 0.01$ . The equation of the cubic model obtained is  $y = -0.495x^3 + 60.06x^2 - 2562x + 49932$ . Figure 5 shows the average values and the graph of the cubic model obtained depending on them.

The decrease in the estimated sales price (ESP) of tractors with the increase in age in tractors in the second hand market

is similar to the results given in the literature (Isik et al. 1995, Guher 2008, Basol 2006).

As a result of the statistical analysis made with the average estimated sales price values of tractors with the same usage hours, the distribution of the estimated sales value of tractors in the second-hand market based on the total operating time (TOT) is second-order ( $R^2 = 0.4858$ ,  $p < 0.01$ ). ) a relationship has been identified. The equation of the model obtained is  $y = 0.000005x^2 - 2.4593x + 39792$  (Figure 6).

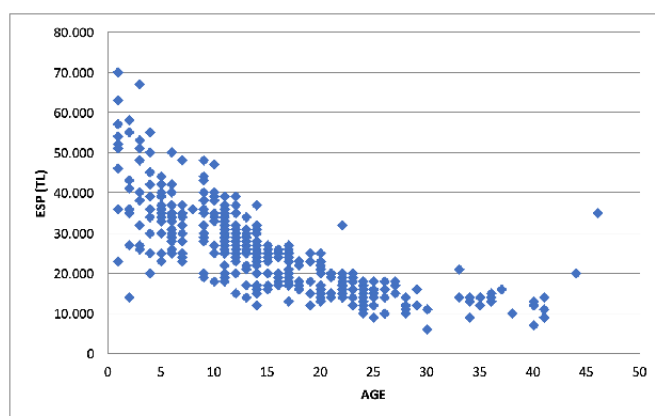


Figure 4b. Age-related change in the estimated sales price (ESP) of tractors in the second hand market



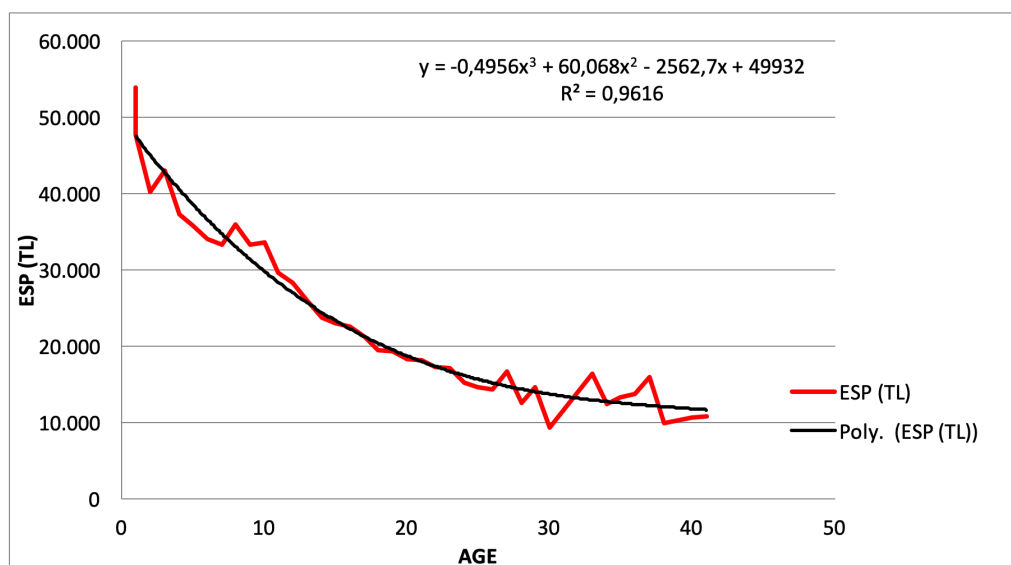


Figure 5. Changes in the age-estimated sales price (ESP) values of tractors in the second-hand market according to average values.

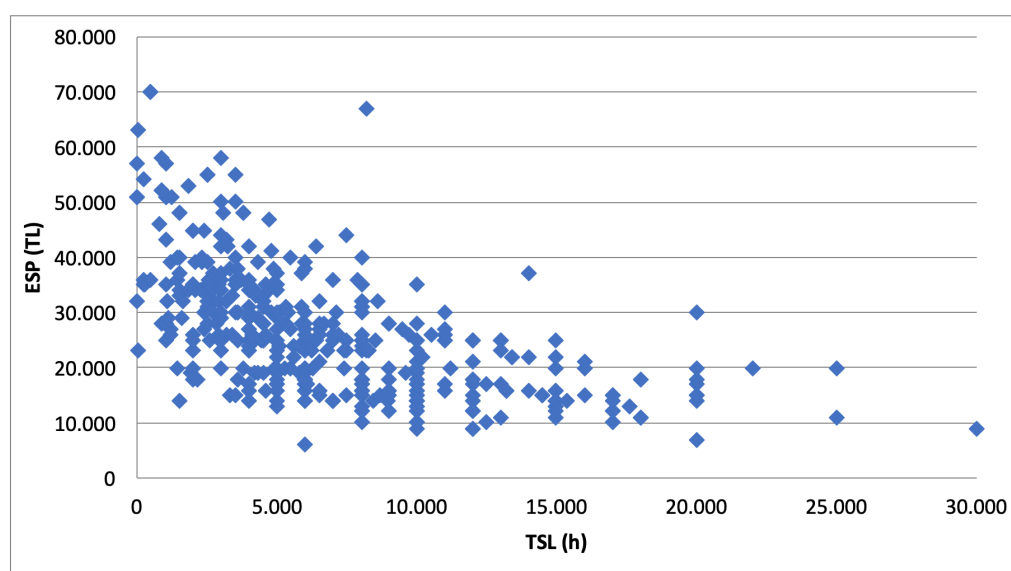


Figure 6. Variation of the estimated sales price (ESP) of tractors in the second hand market depending on the total service life (TSL)

In the study, the average annual life of the tractor was obtained by proportioning the total usage time (TUT) read from the tractor meter to the age. Figure 7 shows the distribution of estimated sales price (ESP) values depending on the TUT/AGE parameter.

Statistical analysis revealed that there was no relationship between the TUT/AGE parameter and ESP that could be subject to the model. The estimated sales price (ESP) of the tractor in the second-hand market is determined by the effects of various factors. The first factor that comes to mind among these is the tractor's rated engine power (REP).

As a result of the analyzes made for the purpose of modeling the relationship between the estimated sales prices of tractors in the second-hand market and the nominal engine power, the estimated sales price values depending on the nominal engine

power can be converted to a third-order (cubic) function ( $R^2 = 0.821$ ,  $p < 0, 01$ ) level.

The equation of the cubic model obtained is  $y = 0.163x^3 - 13.94x^2 - 532.5x + 11242$ . The result obtained here shows that the rated motor power factor has a high effect, approximately 82%, on the estimated sales price (Figure 8).

On the other hand, it was previously determined that the age-related estimated sales price values fit a third-order (cubic) function with a high degree ( $R^2 = 0.961$ ), at the level of  $p < 0.01$ . Accordingly, the age parameter has a higher effect on the estimated sales price than the nominal motor power parameter. These values are similar to the values given in the literature (Basol, 2006). As a result of the analyzes aimed at determining the effects of both parameters on the market value together, the following equation has been obtained:

$ESP(TL) = 20109,187 - 835,793 \cdot AGE + 325,623 \cdot REP$   
(kW)

In this equation,  $R^2 = 0.637$  and  $p < 0.01$ , while the standard error of the estimation made using the equation is  $\pm 6719.26$

TL. The data obtained within the scope of the study are in great agreement with the results obtained in the study of Isik et al. (1995) in the literature and previously reported.

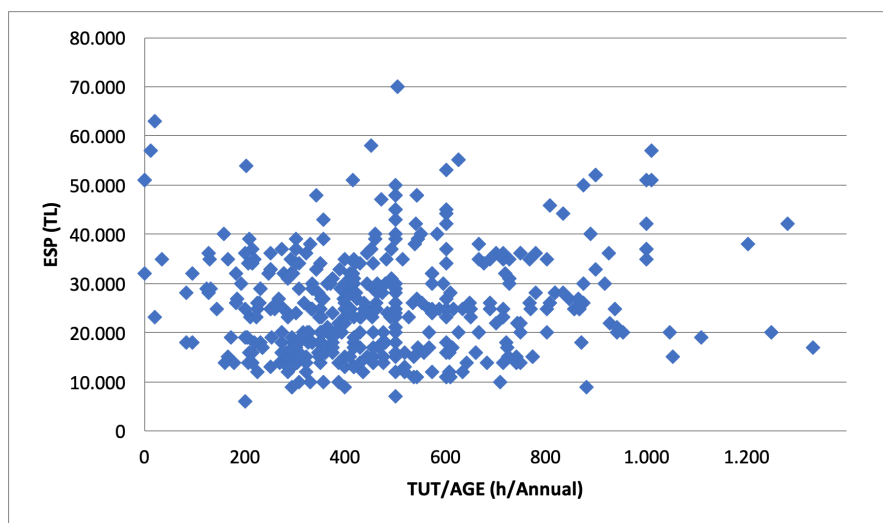


Figure 7. Variation in the estimated sales price (ESP) of tractors in the second hand market depending on the average annual usage period (TUT/AGE)

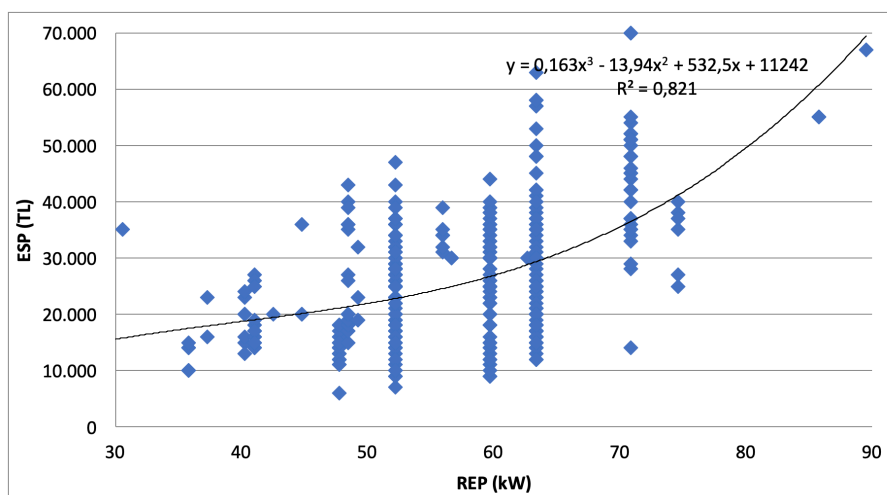


Figure 8. Variation of the estimated sales price of tractors in the second hand market depending on the average rated engine power.

Likewise, when the estimated sales price of the unit rated engine power of tractors is shown with the ratio of ESP/REP, the change of these values depending on the age is seen in Figure 9. In this graph, the average of the ESP/REP values of different tractors of the same age was obtained, and the observation values in Figure 10 were obtained. It was determined that the observation values in this way fit a third-order model with an indication coefficient of  $R^2 = 0.563$  and a probability level of  $p < 0.01$ .

The equation of the cubic model obtained is  $y = 0.020x^3 - 1.364x^2 + 16.07x + 470.9$ . In other words, it is observed that due to the increase in tractor age, the estimated sales price

(ESP) for unit power decreases within the framework of the determined model.

In order to have information about the depreciation characteristics of tractors in the second-hand market, used tractors, of which new ones are still produced and sold, were also analyzed. For this purpose, the ratio of estimated sales price (ESP) values to the sales price (SP) of the new one of the same tractor was used as the analysis parameter. The change of the values obtained is given in Figure 11.

Analyzes for tractors in the second-hand market highlighted two different model types. The first of these is the linear model and it has a coefficient of indication of  $R^2 = 0.483$  and a



probability level of  $p < 0.01$ . The equation for the linear model is  $y = -1,352X + 64.11$ . The second model is the cubic model with a third order equation. In this model,  $R^2 = 0.856$  and  $p < 0.01$ . The equation for the cubic model is  $y = -0.017X^3 + 0.879X^2 - 13.34X + 89.66$ . Analyzes made by Hunt (2001) for US conditions based on the age-dependent value (the value

of the tractor at the beginning of the year - the depreciation amount for that year) also showed a very strong ( $R^2 = 0.924$ ,  $p < 0.001$ ) cubic model between these two parameters. revealed that it was found. A similar result can be obtained with the values given by Witney (1988b).

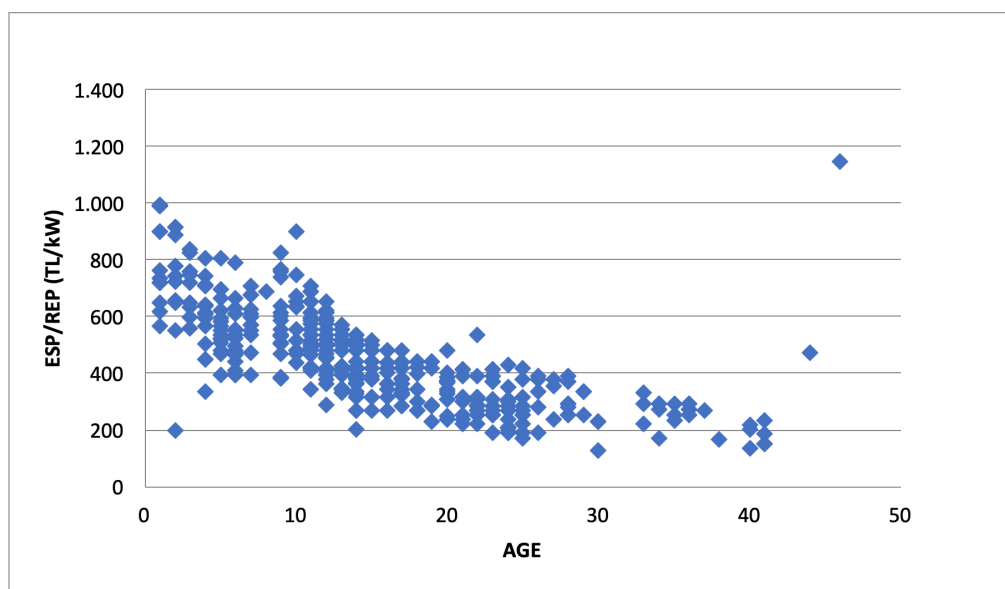


Figure 9. Age-dependent variation of the estimated purchase price (ESP/REP) of the unit rated engine power of tractors in the second hand market

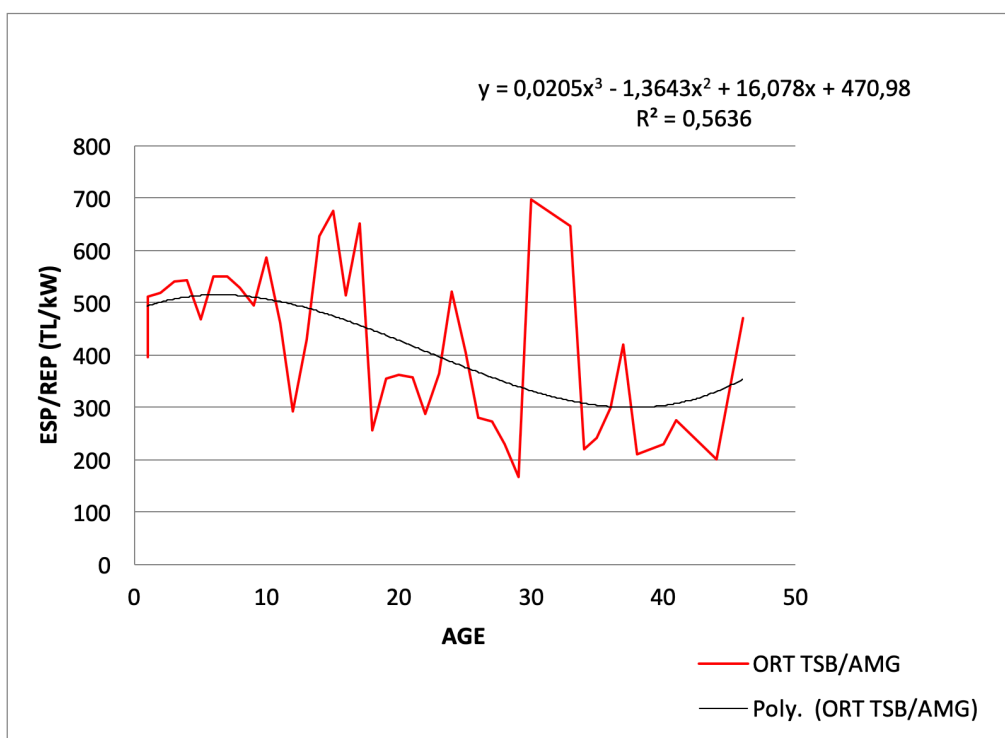


Figure 10. The change of age-related ESP/REP values obtained according to the mean values and the graph of the cubic model obtained accordingly

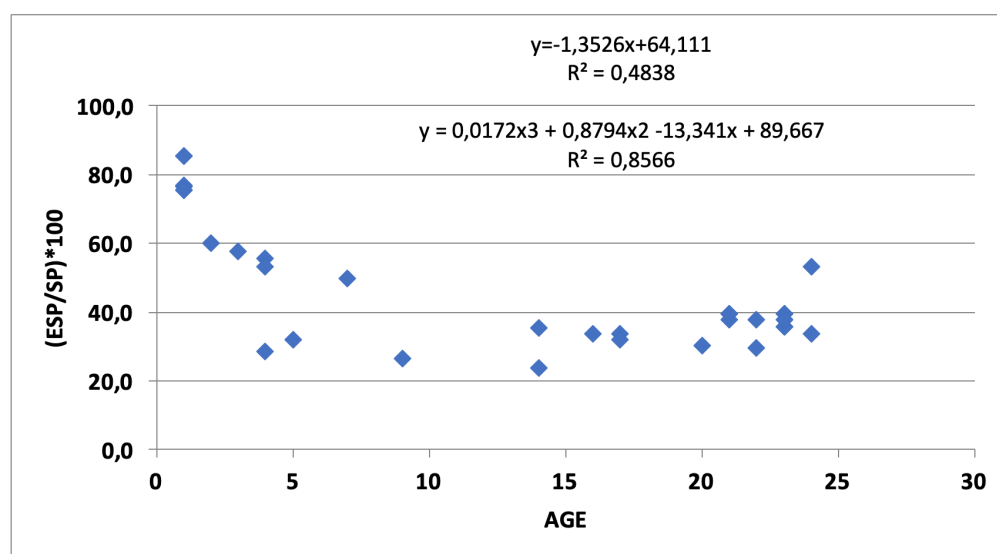


Figure 11. Age-related ESP /SP values of tractors in the second hand market

### Results and Conclusions

With this study, the properties of used tractors for sale in Sanliurfa Harran Plain (Central, Harran and Akcakale Districts) were tried to be determined. These features and some other factors that are thought to be effective were analyzed and their degree of influence was investigated. Studies conducted have revealed the results summarized below. According to this:

1) The average rated engine power of tractors in the second hand market in the research area is 57 kW, while the rated engine power of the tractors varies between 35-89 kW, while the power distribution is in the range of 50-65 kW, which is also described as the medium power group.

2) The average age of tractors in the second-hand tractor market is approximately 15, and tractors in the 0-15 age group constitute approximately 60% of the total tractors and 30% in the 16-30 age group. It is seen that 43% of the tractors in the second hand market are 15 years old and older tractors. Considering the 15-year economic life given in the literature for tractors (Sabancı et al. 2003a, Sabancı et al. 2003b), this situation reveals that the use of tractors that have completed their economic life is quite significant. However, when we look at the sales reasons for the tractors in the second hand market, 48% of the tractors are due to model aging, 2% to wear and again 2% to lack of capacity. This shows that more than half (52%) of second-hand tractors in the market have been put up for sale for upgrades; this reveals the renewal potential of the tractor park in Şanlıurfa Harran Plain.

3) The average annual usage time of tractors in the second hand market is 432.8 hours. When the product projections proposed for the region in both the GAP Master Plan (Anonymous 1989) and the GAP Regional Development Plan (Anonymous 2001b) are implemented, these values for the average tractor usage periods are calculated as the tractor used economically (650 h/year) or effectively (850-1000 h / year). years). In order to increase this period, it is necessary to increase the use of agricultural machinery foreseen by irrigated

agriculture depending on the variety of product patterns of the enterprises.

4) As a result of the analysis of the regression analysis between the total usage time (TUT) of the tractors in the second hand market and the age parameters, it was observed that the total usage time of the tractor increased depending on the age of the tractor.

5) It has been observed that there is a strong negative relationship between the age-related market value of tractors in the second-hand market and the age-related estimated sales price. The price determination for used tractors is based on market conditions. Average prices are determined by model (age) and rated engine power and brand. Price values, which are highly affected by the general economic situation, are adopted by almost all market players. Other features of the tractor may have little effect on the actual price.

6) For tractors in the second hand market, it has been determined that the average annual service life is independent of the rated engine power.

7) Approximately 49% of the variation in the estimated sales price (ESP) of tractors in the second hand market can be explained by the variation in the total usage period.

8) It has been revealed that there is no relationship between the average annual service life (ASL/AGE) parameter of tractors in the second hand markets and the estimated sales price (ESP) that can be subject to the model. It is thought that the low annual average usage time of tractors is effective on this result.

9) The 82% of the variation in the estimated sales price of tractors in the second-hand market can be explained by the change in the rated engine power (REP) of the tractors. In this context, it has been determined that the rated engine power (REP) is very effective in price formation, especially for tractors in the second hand market.

10) The 56% of the change in unit power price (ESP/REP) in tractors in the second hand market is due to the age factor.

**Compliance with Ethical Standards****Conflict of interest**

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**Author contribution**

The author read and approved the final manuscript. The author verifies that the Text, Figures, and Tables are original and that they have not been published before.

**Ethical approval**

Not applicable.

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**Data availability**

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