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Mechanization Properties and Users' Evaluations of Farm Tractors in Eastern Mediterranean Turkey

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Abstract: This study was conducted to determine mechanization properties of widely used tractors in Eastern Mediterranean Turkey and to evaluate farmers' opinions on these tractors. A sample of 205 randomly selected farmers were interviewed. It was found that 89.3% of the farms had one tractor and 20.8% of the tractors have completed their economic lives. The average engine power was 47.83 kW. Average operating time for a tractor was approximately 600 hours per year. Tractor power was 4.2 kW per hectare and average farm area was 11.52 hectares per tractor. The Pearson correlation coefficient between the farm size and tractor power, farm size and number of tractors, farm size and operation time of tractor, and tractor power and operation time of tractor were found to be 0.43 (moderate correlation), 0.82 (very strong correlation), 0.34 (moderate correlation), 0.22 (low correlation), respectively. It was concluded that tractors were used more efficient in big farms, farm size was properly taken into account for choosing a farm tractor, and some farms chose tractors more powerful than necessary. Of tractor operators 84.2% expressed satisfaction with engines, 78.6% with PTO drives, 75.7% with drawbars, 63.6% with three-point hitches, and 84.9% with traction efficiencies.
Key words: Tractor, mechanization, technical properties, farmer evaluation, Eastern Mediterranean

INTRODUCTION

Agricultural mechanization is related not only to plant and animal production carried out with the use of agricultural equipment but the design, production, maintenance, repairing, and marketing of these equipment efficiently (Zeren, 1991). This technology is a complementary factor in terms of increasing the efficiency of other production technologies (conservation and management of soil and water resources, irrigation, fertilizing, etc.), making these technologies profitable and improving the working conditions.

Goals of mechanization could be listed as follows (Liljedahl et al., 1996; Tezer & Sabancı, 1997):

- To make the new technology applications possible for production,
- To make help cope with natural conditions and to provide with quality crops,
- To bring up the working conditions to a more comfortable, more attractive and safer level in the countryside and to increase workers' productivity,
- To improve technical knowledge and ability in the countryside,
- To give opportunity to the new business brunches,
- To make hard works easier with the help of machines and to carry out the operations in a short time,
- To enhance the productivity on agriculture.

Tractors having a significant role on fulfilling the aims stated above constitute a large amount of mechanization investments at the agricultural sector (Alcock, 1986; Liljedahl et al., 1996; Sabancı et al., 2003a). Tractors are the most important indicator at determining the mechanization levels of countries. Tractor-based mechanization level is defined with the units such as the number of tractors/1000 ha, ha/ the number of tractors, the number of agricultural machines/ tractor (Tekelioğlu, 1983; Sabancı et al., 2003b). Therefore, farm size, tractors' power and the number of tractors are important just as being aware of technical properties of tractors in a region or country (Sabancı et al., 2003a).

This subject has a great importance in the regions where agricultural production shows different characteristics and should be evaluated regionally to avoid misinterpretations due to vast variety of climatic, soil, and crop conditions from one region to another. This study was conducted in Eastern Mediterranean, one of the important agricultural regions, in Turkey. The objectives of this study were:

To determine farm size and crop variety of operators and also determine make, type, model, power groups, annual operating times of their tractors,

- To determine the correlation between farm size and tractors' power and the number of tractors,
- To determine users' evaluation of tractors.

MATERIAL and METHOD

Material

The main material of this study was information provided by questionnaires conducted with farmers who use farm machineries in Eastern Mediterranean Provinces of Adana, Hatay, Kahramanmaras, and Osmaniye. The questionnaires were included questions related to farms and technical properties of tractors used. Farmers' evaluations on the performance of the tractors and tractors' specific organs were also determined. Farmers' classification of tractor performance was determined in three categories as bad, moderate and good.

Method

Sample Size Determination

As it wasn't possible to gather data from all of the farms in the region because of time and material needs, the villages and districts were selected on purpose. For this purpose, six villages from each city-two from center and two apiece from two districts-reflecting the agricultural properties of cities in the region were chosen with the help of technicians of Agricultural Province Directorate. In this method, villages were chosen so that they represent the district socio-economically, their distance to the district and their agricultural potential.

A frame list belonging to farm size was formed by getting the necessary information from Agricultural Province and District Directorates. Farms were classified into five parts according to their sizes using stratified sampling method: 0-50 da, 51-100 da, 101-150 da, 151-200 da and larger than 200 da. Main goal of stratified sampling method were to increase the accuracy of sample size determination and to provide efficient representation of different groups in the population. Besides, principal of this method was to divide the population into the homogeneous levels in order to decrease the variance. By this way, a more accurate and detailed study could be possible with the use of fewer samples (Günes & Arikan, 1985). The number of model farms was found by using equation 1 with respect to stratified sampling method (Yamane, 2001).

$$n = \frac{N\sum N_h S_h^2}{N^2 D^2 + \sum N_h S_h^2} \quad \text{.....(1)}$$

$$D^2 = \frac{e^2}{t^2}$$

n : Sample size,
N : Population size,
N_h : Number of units at each level,
S_h : Standard deviation,
D^2 : Variance,
e : Error about the population
t : t critical value.

The number of subjects to whom the questionnaire was applied was determined to be 205 with an average error of ±10% and the confidence level of 95%. When this number was proportionally distributed to five levels, the questionnaire was applied to 107 farms in Adana, 32 in Hatay, 27 in Kahramanmaras and 39 in Osmaniye. More subjects were evaluated in Adana because the villages chosen from this district were more crowded than those chosen from the other cities.

Evaluation of Data

The questionnaire forms were filled out by the farmers and required code plan was prepared for data analysis. In the data analysis, descriptive statistics were used for determining farm size, crop variety, technical properties of tractors (make, type, model, power groups, annual operating times). Pearson Correlation coefficient was used for determining the correlation of data connotatively (Voelker & Orton, 1993) to determine correlation between farm size and tractor power, farm size and total operating hour for a tractor, and tractor power and total operating hour for a tractor. The level of correlation was determined by using Table 1 (Davis, 1971).

Users' evaluations about their tractors were evaluated according to the Triple Likert Scale (1=bad, 2=moderate, 3=fine), and frequency and percentage values of each category were determined.

Table 1. Interpretation of Correlation Coefficient

Correlation coefficient (r)	Definition
0.70 - +	Very strong correlation
0.50-0.69	Strong correlation
0.30-0.49	Moderate correlation
0.10-0.29	Low correlation
0.01-0.09	Neglectable correlation

RESULTS and DISCUSSION

Farm Size

In this study, farm sizes were mostly between 0-50 da (57.1%). Respectively, their sizes were 51-100 da (22.4%), 101-150 da (7.8%), 151-200 da (3.9%), 201+ (8.8%).

Crop Variety

The distribution of crops grown in the studied region is shown in Figure 1. Wheat was most widely grown crop in the region (29.5%) followed by corn (27.8%), vegetable (13.4%) and cotton (12.8%).

Tractor Park

It was found that 89.3% of the farms had one tractor, 7.8% had two, 0.5% had three and 2.4% of the farms had four tractors (Figure2). In a previous survey on Cukurova district the farms having one tractor was determined to be % 72 (Isik, 1996).

Age of Tractors

It was found that 30% of tractors were at the age of 0-5, 36.3% of tractors were at the age of 6-10, 12.9% of tractors were at the age of 11-15, and 20.8% of tractors were at the age of 16 or more (Figure 3). According to this, it could be seen that nearly 65% of the tractors in the region were under the age of 10 and 35% of tractors were over the age of 10. When economic life of a tractors is considered to be 15 years (Tezer & Sabancı, 1997), it can be seen that 20.8% of tractors in this region have already completed their economic lives and 12.9% of tractors would have completed their economic lives in five years.

Make and Model of Tractors

It was found that five different tractor brands are being used in the region. These are Uzel (52.7%), TZDK (18.0%), Türk Traktör (17.2%), Tümosan (2.1%) and Universal (10.0%) (Figure 4). Mostly used tractor types on farms were MF 240 DF (18.9%), Universal 445 (10%), MF 266 G (8.8%) and MF 285 (7.5%) (Figure 5).

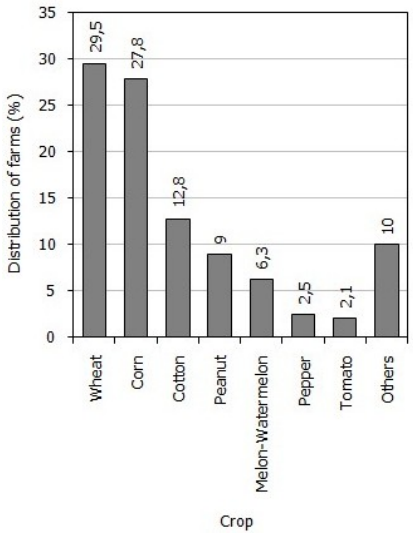

Figure 1. Crop Varieties in the Region

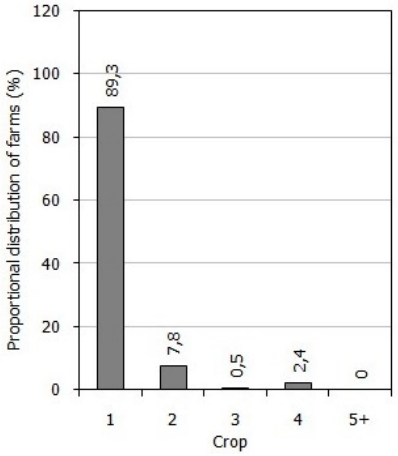

Figure 2. Distribution of operators' tractors

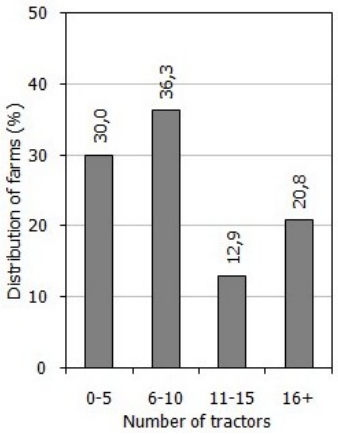

Figure 3. Age distribution of operators' tractors

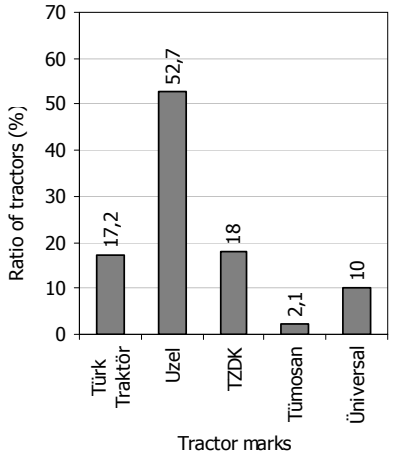

Figure 4. Make distribution of tractors

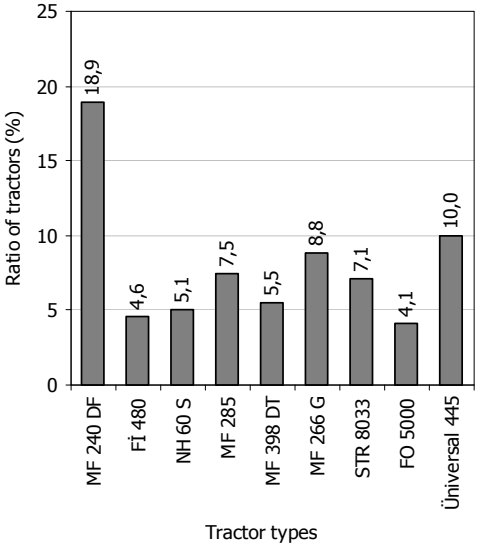

Figure 5. Type distribution of tractors

Power of Tractors

Distribution chart about the power of farmers' tractors was given in Figure 6. In the region there were few tractors whose engine power were under 30 kW (0.4%). It was found that 34% of tractors had 31-40 kW engine power, 17.2% of tractors had 41-50 kW, 48.3% of tractors had 51 kW and more. Average engine power of tractors was 47.83 kW.

Annual Use of Tractors

The operating time of tractors for tractor owners were more than 1000 hours for 32.2% of the farms, less than 500 hours for 27.7% of the farms, and 801-900 hours for 25.5% of the farms. The operating time of tractors at somebody else's works was 33% and

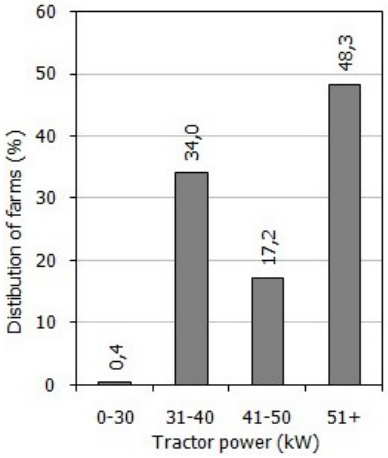

Figure 6. Distribution of tractors as to their power groups

the operating time of tractors at works out of agriculture was 46% (Table 2). The average operating time for a tractor was 596.6 hours. It was 896.4 hours for farmers own works, 183.7 hours for someone else's works, and 159.8 hours for works out of agriculture. Annual usage of tractor in North-West Turkey was determined to be 467 hours (Saglam & Akdemir, 2002). In the present study this results is 129.6 hours higher. This is probably caused by non agricultural use of tractors in the Eastern Mediterranean Turkey.

According to Table 3, average engine power of a tractor was 47.83 kW; mechanization level was 4.2 kW/ha or 86.8 tractor/1000 ha or 11.52 ha/tractor. Mechanization level calculated to be 1.91 kW/ha in a study done by Isik (1996) including Çukurova district. On the other hand, in another less comprehensive study, mechanization level of Kahramanmaraş was determined to be 3.38 kW/ha (Aybek & Hursitoglu, 2002) resulting in a greater value compared with the previous studies. This could be because farmers tend to use more powerful tractors. In addition, data were gathered from farms having a operator. This could be a factor as well.

Average number of tractors per 1000 hectares in the region was 87 (Table 3). This number was 8 in developing countries, 30 in developed countries and almost 19 in the world. The number of tractors was 100 in Germany , 70 in France and 80 in Greece (FAO, 2006). The number of tractors per 1000 hectares in the region was found to be close to the EU members.

Table 2. Annual use of tractors

Indicator	Hours/year	%
Annual operating time for a tractor at farmers' own works	-500	27.7
	501-600	6.7
	601-700	3.3
	701-800	3.3
	801-900	25.5
	901-1000	1.3
	1001+	32.2
Annual operating time for a tractor at somebody else's works	No work	77.0
	1-50	9.6
	51-100	2.9
	101-150	0.4
	151-200	0.8
	201+	9.3
Annual operating time for a tractor at other works out of agriculture	No work	53.9
	1-50	19.3
	51-100	4.6
	101-150	0.9
	151-200	2.5
	201+	18.8

Mechanization Level

Mechanization level indicators for the region were given in Table 3.

Table 3. Indication values of agricultural mechanization level

Farm Size (ha)	Number of tractors	Average tractor engine power (kW)	Mechanization level		
			kW/ha	Tractor/ 1000 ha	ha/ Tractor
2 742.5	238	47.83	4.2	86.8	11.52

Correlation between properties of farms

A strong correlation between farm size and tractor power ($r = 0.43$, $p<0.01$, $n=205$), a very strong correlation between farm size and number of tractors ($r = 0.82$, $p<0.01$, $n=205$), a moderate correlation between farm size and operating time for a tractor ($r = 0.34$, $p<0.01$, $n=205$), a low correlation between tractor power and operating time for a tractor ($r = 0.22$, $p<0.01$, $n=238$) were found (Table 4).

The strong correlation between farm size and tractor power showed that operators in the region took into account farm size sufficiently. The very strong correlation between farm size and number of tractors showed that big operators bought more tractors than others. The moderate correlation between farm size and operating time for a tractor showed that tractors weren't used efficiently by big operators although they were necessary. The low correlation between tractor power and operating time for a tractor showed that operators had a tendency -even if it was a low one- to choose a powerful tractor in order to finish operations in a shorter time within a year.

Table 4. Correlation between properties of farms

Variables	n	r	p
Farm size-tractor power	205	0.43	0.01
Farm size-tractor number	205	0.82	0.01
Farm size–operating time for a tractor	205	0.34	0.01
Tractor power-operating time for a tractor	238	0.22	0.01

Farmers' Evaluations of Their Tractors

Farmers' evaluations of their tractors were given in Table 5. According to these evaluations, 84.2% of the operators in Eastern Mediterranean expressed satisfaction with engines, 60.2% with clutches, 74.4% with gear boxes, 65.2% with differentials, 69.9% with final drives, 75.3% with tires, 78.6% with PTO drives, 75.7% with drawbars, 63.6% with three-point hitches, and 84.9% with traction efficiencies. Therefore, there are opportunities for the tractor manufacturers to improve their tractors for the best adoption to the region.

Table 5. Farmers' evaluations about their tractors

Tractor body	Opinion	%
Engine	Bad	1.60
	Moderate	14.20
	Fine	84.20
Clutches	Bad	3.90
	Moderate	39.90
	Fine	60.20
Gear boxes	Bad	10.10
	Moderate	15.50
	Fine	74.40
Differentials	Bad	4.60
	Moderate	30.20
	Fine	65.20
Final drives	Bad	9.60
	Moderate	20.50
	Fine	69.90
Tires	Bad	2.50
	Moderate	22.20
	Fine	75.30
PTO drives	Bad	8.90
	Moderate	12.50
	Fine	78.60
Drawbars	Bad	3.40
	Moderate	20.90
	Fine	75.70
Three-point hitches	Bad	7.60
	Moderate	28.80
	Fine	63.60
Traction efficiencies	Bad	2.10
	Moderate	13.00
	Fine	84.90

CONCLUSIONS

Conclusions drawn from this study include the following:

1. In the region, farm sizes were mostly between 0-50 da (57.1%).
2. It was found that 89.3% of the farms had one tractor, 7.8% had two, 0.5% had three and 2.4% of the farms had four tractors.
3. Nearly 65% of the tractors in the region were under the age of 10 and 35% of tractors were over the age of 10.
4. Most widely used tractor types on farms were MF 240 DF (18.9%), Universal 445 (10%), MF 266 G (8.8%) and MF 285 (7.5%).
5. In the region there were few tractors whose engine power were under 30 kW (0.4%). It was found that 34% of tractors had 31-40 kW engine power, 17.2% of tractors had 41-50 kW, 48.3% of tractors had 51 kW and more. Average engine power of tractors was 47.83 kW.
6. The operating time of tractors for tractor owners were more than 1000 hours for 32.2% of the farms, less than 500 hours for 27.7% of the farms, and 801-900 hours for 25.5% of the farms. The operating time of tractors at somebody else's works was 33% and the operating time of tractors at works out of agriculture was 46%.
7. The average operating time for a tractor was 596.6 hours, for farmers' own works it was 896.4 hours, for somebody else's works it was 183.7 hours and for works out of agriculture it was 159.8 hours.
8. Mechanization level was 4.2 kW/ha or 86.8 tractor/1000 ha or 11.52 ha/tractor.
9. There was as a strong correlation between farm size and tractor power ($r=0.43$, $p<0.01$, $n=205$) in the region, showing that the farmers took farm sizes into account properly.
10. A very strong correlation was found between farm size and number of tractors ($r=0.82$, $p<0.01$, $n=205$).
11. A moderate correlation was determined between farm size and operating time for a tractor ($r=0.34$, $p<0.01$, $n=205$). This showed that tractors weren't used efficiently by big operators although they were necessary.
12. A low correlation was found between tractor power and operating time for a tractor ($r = 0.22$, $p<0.01$, $n=238$). The low correlation between tractor power and operating time for a tractor showed that operators had a tendency to choose a powerful tractor in order to finish operations in a shorter time within a year.
13. In the region, 84.2% of the operators in Eastern Mediterranean expressed satisfaction with engines, 60.2% with clutches, 74.4% with gear boxes, 65.2% with differentials, 69.9% with final drives, 75.3% with tires, 78.6% with PTO drives, 75.7% with drawbars, 63.6% with three-point hitches, and 84.9% with traction efficiencies. The manufacturers need to take these results into account in order to adapt their tractors in the region.
14. Mechanization level in the region is quite high, resulting in increased mechanization costs in farm operations. Shared use of agricultural machinery may provide economic benefits.
15. There are many tractors close to their economic lives, so there will be a potential of purchasing new tractors among the farm operations in the near future. Manufacturing companies should be aware of farmer demands and make design alterations accordingly.

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