THE EFFECTIVE USE OF AGRICULTURAL TRACTORS IN TURKEY: AN EXAMPLE OF ESKISEHIR

Eng. ALTINTAS N. 1, Prof. Dr. Eng. OZCELIK A.2
Republic of Turkey Ministry of Food Agriculture and Livestock1, Ankara University2, Turkey
E-mail: nesealtintas@gmail.com, aozcelik@agri.ankara.edu.tr

Abstract: The survey farms that were prepared have been filled by 122 farmers who were tractor owners and have been analyzed. The farms were evaluated in two groups; the means are determined for Group I farms (1-259da), Group II farms (250da&greater). The most preferred usage model of multi-farm use of machinery was collectivization with neighbors. The busiest months for tractor using were April, October and September. According to different modelings, it was found that 1 tractor could be used in common by 4 farms in April in which the tractors was being used more intensely in Group I farms. It was determined that, according to the general opinions of the local farmers, “Machine Rings” was appropriate for the circumstances of Eskisehir. As it was determined that 1 tractor could not be used in common by even 2 farms in April, it was considered that it might be suitable to have tractors belong themselves when the land size was taken into account in Group II farms. When compared ownership with rental in terms of costs, having a tractor generally seems advantageous.

KEYWORDS: Tractor, use efficiency, used in common tractor, ownership tractor.

1. Introduction

To meet the needs of the rapidly growing human population, more abundant and high quality production per unit area is one of the main objectives of today's agricultural production. This object is accomplished by taking advantage of new technologies. The technologies used in agricultural production are as follows;

- Irrigation,
- Fertilization,
- Plant protection,
- Development and use of breeding materials,
- Protection and regulation of soil and water resources,
- Applications of agricultural mechanization (Tezer and Sabanci 1997).

Agricultural mechanization has a special place among the production technologies. Agricultural mechanization is such a supplementary production technology that it increases effectiveness of other inputs in agricultural production, economize, and improve working conditions (Zeren et al. 1995). Due to the high initial investment and amortization, rational use of agricultural tools and machines has an important place in agricultural activities and can bring profit. With the selection of agricultural mechanization equipment based on structure of its enterprise will reduced mechanization investment, operating costs, and will allow agricultural operations to be made in a timely manner to provide valuable contributions to enterprise economy (Akıncı 2003). For the efficient use of mechanization in agriculture it is necessary to study existing conditions of mechanization in farms, educate farmers and inform the tractor manufacturer based on the results achieved for effective usage of mechanization in production (Şenel 2006).

For purchasing, joint tenancy and rental situations of the tractors, an evaluation of mothly use of tractor, identification of operating expenses and cost components and comparison of expenses in case of renting tractors are necessary. Hence, a comparison between purchasing and renting of a tractor based on evaluation of mothly use of density or advantage of whether single or multi-farm use of the same tractor at the same time period can also be accomplished.

2. Prerequisites and means for solving the problem

2.1. Material

The main material of this research is the data collected through a survey done by farmers. The obtained data represents to the production period 2011 – 2012 and survey was made between January and March 2013.

3. Solution of the examined problem

3.1. Methods

3.1.1. The method applied to sampling stage

Firstly, the number of tractors in 2010 was determined on the basis of Eskisehir districts, then, the tractor / 1000ha which is in one of the most important indicators of the presence of a tractor in a region was calculated.

Districts which were comprising closely spaced ratios on the basis of the ratio tractor / 1000 ha were evaluated, and 5 groups were formed. The districts were identified from each group as to ensure their geographical representation on the basis of Eskisehir map. Based on this criterion five districts such as Günuyüzi, Çifteler, Alp, İnönü and Sarıçakaya were selected as research areas.

Taking the tractor / 1000 ha ratio and transportation availability into account, 5 villages, one with low an one with high and three with moderate levels, were defined on the basis of representing proximity to mean value. Research population (sampling population) in the study were also constituted by farmers which have their own tractor in selected villages. Names and land size of farms which was pinpointed on the chart and had their own tractor was also identified by visiting their villages. Accordingly, the number of farmers owning tractor were 1388 and the average size of land per farm is 123 decares (12,3 ha) in the study area. Due to the fact that coefficient variation of farm size (in ha) in study area was up to 75 %, and separation to layers of the population method was adopted. In this respect, land size of farms were aligned based on their magnitudes. Hence, two separate clusters were formed based on the frequency table. Clusters were seperated into two layers as 1 – 259 acres, and 260 acres and greater. Each clusters showed a homogeneous distribution in itself.

The "Stratified Random Sampling Method" were used for determination of the number of samples in the layers. For this purpose, the following formula was also used (Yamane 2001).

$$n = \frac{N \cdot \Sigma (N_h \cdot S_h^2)}{N^2 \cdot D^2 + \Sigma (N_h \cdot S_h^2)}$$

In this formula;

- $n$: Sample size,
- $N$: The number of units in the population,
- $N_h$: The number of units in the layer h,
- $S_h^2$: The variance of the layer h,
- $D^2 = d^2/2z^2$,
- $d$: The maximum amount of error or the difference between the average of population and sample which may be considered by the investigator,
- $z$: Z value the table of the standard normal distribution according to this margin of error.

The 10% error and in the 95% confidence limits were used for determination of the sample size. Based on the calculations, the 122 samplings out of 1388 farms which have their owned tractor were determined. Variance of the layers was based on the determination of farms which will enter the sample from each layer. Sharing Method was used for the Layer Variance. The sample size taken from each layer is as follows;

<table>
<thead>
<tr>
<th>Layer</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 259 acres</td>
<td>77</td>
</tr>
<tr>
<td>260 acres and greater</td>
<td>45</td>
</tr>
</tbody>
</table>

It was calculated that 97 samples from first layer (1-259 acres) and 25 samples from second layer (260 acres and greater) is...
required (Table 1).

**Table 1. Determination of sample size**

<table>
<thead>
<tr>
<th>Layer</th>
<th>N</th>
<th>Average</th>
<th>s</th>
<th>N  \cdot S</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-259 acres</td>
<td>1224</td>
<td>89.33</td>
<td>62.8</td>
<td>9382010.3</td>
<td>97</td>
</tr>
<tr>
<td>260&amp;greater</td>
<td>164</td>
<td>376.45</td>
<td>123.5</td>
<td>2470373.3</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>1388</td>
<td></td>
<td></td>
<td>2602473.3</td>
<td>122</td>
</tr>
</tbody>
</table>

Farms selected as samples were identified using "Random Numbers Table".

3.1.2. The method applied to survey stage

Direct interview method was used in the process of gathering material.

3.1.3. The method applied to analysis stage

Surveys conducted in farms were analyzed. They were transferred to the computer to make necessary controls, completion and the editing process in the framework of "Plan Code". Data was converted into table summary information in the form. Farm groups were taken place in the presentation of data in table, economic analysis and evaluation.

3.1.3.1. The analysis of used in common tractors and ownership in terms of density of time of use as months

Firstly, three different models were created in order to assess the monthly use of tractors. Then, assessments were made on these models. The monthly distribution in hours of the use of tractor in plant production were identified. Finally, daily use of tractors were also calculated. Another use of the tractor is also distributed equally per day on farm groups since there were not concentrated on use in animal production and other non-agricultural uses. It was also determined that how many farms will commonly use a tractor based on maximum 8-hour-usage.

3.1.3.2. Analysis of tractor ownership and rental in terms of costs

Firstly, crops grown and have economic value in study area were taken into account. To this end; crops which have more than 3% of the total farm land in farms analyzed (wheat on irrigated fields, wheat on dry fields, barley on irrigated fields, barley on dry fields, sugar beet, sunflower as oil, and potato) and were selected.

Cost components for the product in question were determined as per decare. Then, costs were identified based on when the tractor was 'hired' and was 'not hired' options were undertaken. Transactions made with tools and machine were determined based on number of times the transaction, hours of tractor use and fuel costs for each product. The labor costs were evaluated on the basis of the current village daily work (10 hours of work). Family labor was evaluated based on the assumption of wage workers.

Given the costs groups in evaluation;

a) Variable Costs
- Soil cultivation and sowing-planting expenses,
- Maintenance costs (fertilization, watering, spraying, etc.),
- Harvesting-threshing and transport expenses,
- Various inputs (seeds, seedlings, fertilizers, water, pest control, etc.)
- Tractor variable costs,
- Circulation Capital Interest
b) Constant Costs
- General administrative costs,
- Land Tenure
- Tractor constant costs.

For the seeds, seedlings, fertilizers and pesticides, current prices on the market were taken into account assuming they were purchased from outside (Altıntaş and Altıntıaş 2012).

As the tractor variable cost; the amount corresponding to the oil, maintenance and driver costs for tractor were used.

As the circulation capital interest; half of the rates of interest of Ziraat Bank for crops was taken into account by extending period of the production costs and the duration of stay depends on the capital in agricultural production as interest on circulation capital (Güneş et. al. 1988, Erkuş et. al. 1995). General administrative costs were calculated based on 3% of the total variable costs (Güneş et. al. 1988, Erkuş et. al. 1995).

For the tractor constant cost; the amount corresponding to the product of depreciation, taxes, protection, insurance and fixed capital interest which were made for tractors were used.

The sum of total expenses incurred per decare was calculated as the total variable costs + total constant costs.

In order to identify the costs that would not be undertaken jobs commissioned by rent, the amortism calculated per tractor among all costs, taxes, protection, insurance, fixed capital interest and constant cost elements such as oil, repair-maintenance, driver costs were primarily addressed. These charges were calculated as the share of the costs per farm. Then, basing on the proportion total annual use of hours of tractor and hours used per decare for the product was calculated and the total cost for that of product was estimated.

Total costs incurred for tractor and the costs in the event of rental was compared. The advantage of whether owning tractor or renting in terms of costs were compared.

4. Results and discussion

4.1. The evaluation of use of tractors with joint tenancy and ownership in terms of density of time of use as months

About 62% of agricultural farms in Turkey is between 1 and 5 decares in size and prices of new technological machinery is high; hence it is difficult to obtain tools and machines for agriculture. One of the measures to be taken to solve the problem is to ensure individual purchasing of machines not to be the only alternative, and extend the use of machines with joint tenancy model (Sayın 2006). However, hours of tractor use are needed to be determined whether or not it allows them to use in common as the months of tractor density. For this purpose; 3 different models were defined containing different production patterns. To set the Model I; products with more than 1% of the average acreage per farm land has been identified in the surveyed farms as Group I and Group II. Modeling of crop design was made for both groups for farms based on acreage of these products within the average farm land. How much to have cultivation of which crops in each group of model was also identified. For this purpose the ratio of the cultivation of the crop which would take place in the model to the average farm land was used.

Sample model was formed by proportioning to the average farm land of the ratio of crops with higher acreage than 1% of average farm land as groups. Hours of tractor use were calculated based on cultivation areas of crops as months the model which formed. After determining hours of tractor use, other tractor use (livestock, farm going / coming and other non-farm, non-farm) was evenly distributed on crops included in the I. model as the designated acreage as months. The hours for tractor use were determined as per month.

After adding the hours used in plant production, the maximum number of farms which would be operated by a tractor in 8 hours as land tenure system and results are given in Table 2. As seen on the table; tractor use in the first group (group I) are 338.43 hours. This value was calculated as an average of 349.01 hours / year considering all the activities of the farms. The total hours of tractor use are 707.01 hours / year in the II. group farms, while it was calculated as an average of 708.01 hours / year based on all activities average. These values clearly show that implementation of the model is much closer to the actual average.

Even in April, which is the most intense month, one tractor can be used by 4 farms in the Group I of farms (table 2). While two farms can not commonly use one tractor in April,
only two farms can commonly use one tractor in March, September and October in the Group II of farms (table 3.1). In this case, it can be stated that the presence of tractor can afford to use only at their work and commonly use of the tractor on time in the Group II of farms is difficult.

### Table 2. The distribution of total hours of tractor use as months for I. model which designed in the year 2011

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Group Farms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.41</td>
<td>0.79</td>
<td>12.90</td>
<td>31.01</td>
<td>4.93</td>
<td>8.10</td>
<td>9.23</td>
<td>5.29</td>
<td>14.85</td>
<td>21.03</td>
<td>4.18</td>
<td>0.44</td>
</tr>
<tr>
<td>C</td>
<td>19.54</td>
<td>18.07</td>
<td>32.03</td>
<td>49.53</td>
<td>24.06</td>
<td>26.62</td>
<td>28.36</td>
<td>24.42</td>
<td>33.37</td>
<td>40.16</td>
<td>22.70</td>
<td>19.57</td>
</tr>
<tr>
<td>D</td>
<td>0.63</td>
<td>0.65</td>
<td>1.03</td>
<td>1.65</td>
<td>0.78</td>
<td>0.89</td>
<td>0.91</td>
<td>0.79</td>
<td>1.11</td>
<td>1.30</td>
<td>0.76</td>
<td>0.63</td>
</tr>
<tr>
<td>II. Group Farms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.86</td>
<td>4.49</td>
<td>81.98</td>
<td>148.45</td>
<td>26.42</td>
<td>40.67</td>
<td>46.73</td>
<td>20.47</td>
<td>77.78</td>
<td>83.77</td>
<td>34.27</td>
<td>3.69</td>
</tr>
<tr>
<td>B</td>
<td>11.67</td>
<td>10.54</td>
<td>11.67</td>
<td>11.30</td>
<td>11.67</td>
<td>11.30</td>
<td>11.67</td>
<td>11.67</td>
<td>11.30</td>
<td>11.67</td>
<td>11.30</td>
<td>11.67</td>
</tr>
<tr>
<td>C</td>
<td>12.53</td>
<td>15.03</td>
<td>93.65</td>
<td>159.75</td>
<td>38.09</td>
<td>51.97</td>
<td>58.40</td>
<td>32.14</td>
<td>89.08</td>
<td>95.44</td>
<td>45.57</td>
<td>15.36</td>
</tr>
<tr>
<td>D</td>
<td>0.40</td>
<td>0.54</td>
<td>3.02</td>
<td>5.32</td>
<td>1.23</td>
<td>1.73</td>
<td>1.88</td>
<td>1.04</td>
<td>2.97</td>
<td>3.08</td>
<td>1.52</td>
<td>0.50</td>
</tr>
<tr>
<td>E</td>
<td>19.79</td>
<td>14.90</td>
<td>2.65</td>
<td>1.50</td>
<td>6.51</td>
<td>4.62</td>
<td>4.25</td>
<td>7.72</td>
<td>2.69</td>
<td>2.60</td>
<td>5.27</td>
<td>16.14</td>
</tr>
</tbody>
</table>

A: Plant production, B: Out of plant production: C: A+B, Total: D: Per a day (C/30-31 day),

After determining hours of tractor use, other use of the tractor was added evenly on day crops included in the III. model as the designated acreage as months. Maximum number of farms tenured was also determined with these hours of tractor use by taking the hours of tractor use in crop production and use of daily 8-hour tractor into consideration.

According to this model (Model III); it was reached to a conclusion that 5 farms tenured could be even in April which is the most intensive month in the Group III farms. Whereas it is not possible used in common by only two farms for the same month in the Group II farms.

Intensity of tractor use in April and September was found just enough to make a single farm's works. Due to the achievement of results that two farms can use in common tractor in October. This group was not considered appropriate to use in common tractor.

### 4.2. The evaluation of tractor ownership and rental in terms costs

Cost components were determined for wheat on irrigated fields, wheat on dry fields, barley on irrigated fields, barley on dry fields, sugar beet, sunflower as oil and potato which grown in farms surveyed were calculated separately according to the costs made by the farmers and will do if the tractor rental. These were presented in table 3.

It can be stated that tractor ownership is more advantageous than tractor hire in crops determined in the both groups farms according to the calculation of the costs incurred in wheat in irrigated fields, wheat on dry fields and barley on dry fields. Although costs incurred by the tractor hire are less than tractor ownership in barley on irrigated fields and sunflower as oil in the Group I farms, the difference is quite small. Whereas tractor ownership is more advantageous than tractor hire in the sunflower as oil in the Group II farms. It is shown that tractor rental is advantageous in the cultivation of sugar beet and potato. However, to be certain costs items arising from the rental is lower than the tractor ownership showed itself especially in intensive use of labor costs (like costs harvesting / threshing by hand incurred). evaluation of tractor ownership in terms the employment of family labor and of providing the possibility to do work on time is assumed to be very important. This is necessary for the farms to decide by looking at the differences in costs in this regard.
Table 3. The costs which occurred on the crops determined and will be undertaken if the tractor hire in the farms surveyed (TL / da)

<table>
<thead>
<tr>
<th>Crops</th>
<th>I. Group Farms (1-259 da)</th>
<th>II. Group Farms (260 da &amp; greater)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Costs occurred</td>
<td>Costs if tractor hire</td>
</tr>
<tr>
<td>Wheat (1)</td>
<td>233,81</td>
<td>242,13</td>
</tr>
<tr>
<td>Wheat (2)</td>
<td>167,91</td>
<td>174,10</td>
</tr>
<tr>
<td>Barley (1)</td>
<td>229,81</td>
<td>223,15</td>
</tr>
<tr>
<td>Barley (2)</td>
<td>154,96</td>
<td>157,41</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>787,41</td>
<td>774,50</td>
</tr>
<tr>
<td>Sunflower</td>
<td>327,14</td>
<td>320,03</td>
</tr>
<tr>
<td>Potato</td>
<td>734,53</td>
<td>689,78</td>
</tr>
</tbody>
</table>

1: in irrigated fields, 2: in dry fields

5. Conclusion
The average age of the tractor is 17.39 in surveyed farms. It is obvious that the regeneration of the tractor has completed its mechanical life due to increased repair and maintenance costs. Production pattern in farm is important in making decisions about the tractor. It is evaluated that there are not important changes in tractor use in crop production as months in first and second group of farms. It is considered that there has been small differences is composition of the differences in product design. The peak months of tractor use are in April, October and September, respectively, in both groups. To make tractor use more efficient in the agricultural business, the farm is required to have a certain size. It was appeared that at least four farms might use one tractor together in April, which is the most intense use of tractors in I. group farms. More precisely; there is power tractors that can be used jointly with other businesses in the I. group farms. In order to use these idle capacity it is necessary to inform the farmer on the used in common machine/tractor. While two farms can not use on tractor commonly in April, only two farms can use 1 tractor together in September and October in the II. group farms. In this case; it was identified that economic usage limit has been reached even exceeded for a tractor.

The tractor existence can afford to use in only their work, used in common is difficult to be able to work on time, tractor power is not much according to both production pattern which existing and production patterns suggested by the models in the II. group farms. The opportunity to work on time becomes and decreases the dependency to other farms/tractor ownership. In this case; it was considered to be a better choice that tillaging the soil in time, planting, harvesting and blending with their tools-machines without delay in the II. group farms. Therefore, it was concluded that commonly used machinery can be grouped based on the size of farm lands. The farms with low income level with the use of common tractor can be provided to reach the economic usage limit of tractor and idle capacity will be evaluated. It can be achieved that falling of unit costs by operating close to full capacity of tractor. Thus, an increase in the agricultural income can be expected. The models which used in common machine and local farmers' opinions are considered together; Machine Ring has been found the right to give effect by adapted to the conditions of Eskişehir province. However, it is required to support the farmers aspects technical and economic in order to perform theses type of organizations. Successful organizations which will be organized in the region to help neighbors is the place spread as good example applications. In this regard, it should not be forgotten that the most important criterion is the satisfaction of as much as possible desire to make work time of farmers. It will be possible to the machine tools capital which with the largest share in the enterprise capital to route different investments with used in common machine.

Cost analysis is also important to decide whether tractor ownership is economic and reduce costs. Therefore, the differences between tractor ownership and rental preferences was examined in terms of costs. There are costs incurred by the farmer when they own the tractor. When compared ownership with rental in terms of costs owning a tractor seems to be advantageous. However, some expense items arising from rent is lower than owning the tractor. This, especially showed itself in densely costs of labor utilization costs made by hand as harvesting / threshing. The evaluation by accepting family labor as wage workers herein is effective. It seems important decision of farmers to ownership tractor that the evaluation in terms of employment of family labor and providing the possibility to do work on time and looking at the differences in costs from this point of in the branches of production which were seen as to rental tractor. Costs of tractors are expected to be decreased with the renewal of the park, and consequently will render the ownership of a tractor more advantageous. Of course; to keep accounting records is necessary and important in making the right decision of the farmer. Training activities should be organized to inform the farmers on this issue.

The evaluation by working in different provinces and results obtained from this study is considered that it will provide benefits in terms of country's agriculture and the policies of mechanization.

6. Literature