

## PRODUCTIVITY OF NEW HOLLAND FARM TRACTOR AT BEECH STANDS ON MOUNTAINOUS AREAS IN BLACK SEA REGION

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### ***Abstract***

In the Black Sea region located in north of Turkey, timber extraction with skidding vehicle is the most common system and also the one that tends to cause erosion problems. The combination of the timber type and topography limit harvesting mechanization to perform transport operations. Rubber tires tractors are used on the more gentle slopes and on skid roads on steeper terrain. In this study, productivity of New Holland farm tractor in beech stands was tested in the area of Gurgentepe Local Forest Enterprise within the Ordu Forest Administration in Turkey. Timber was skidded uphill by New Holland farm tractor in felling area. Time study of a cycle was carried out by using collected data and by statistical analysis. In this study, skidding distance ranges between 140 and 320 m. Hourly productivity are  $11.350 \text{ m}^3 \cdot \text{hour}^{-1}$  for skidding distance of 140 m,  $7.700 \text{ m}^3 \cdot \text{hour}^{-1}$  for skidding distance of 320 m. The cost of cubic meter of skidding are 4.5 \$ and 8.6 \$ as different distance. The average fuel consumption are  $6.0 \text{ l} \cdot \text{hour}^{-1}$ .

**Key words:** New Holland tractor, skidding, productivity, cost, time study.

### **Introduction**

The combination of the timber type and topography limit harvesting mechanization to perform transport operations. Rubber tired skidders are used on the more gentle slopes and on skid roads on steeper terrain (Gholami and Majnounian 2008). In many regions of the world, farm tractors have been used in forestry where the terrain conditions and the size of the forest operation are not limiting (Akay 2005). A farm tractor was modified to become a single grip harvester. Farm tractors are often used in forest

operations, particularly in small scale forestry (Johansson 1997). Mechanization started with the introduction of farm tractors modified by installation of additional equipment, which enabled easier and safer work in the forest. Modified farm tractors play an important role in forest exploitation, even after the development of specialized forest articulated tractors (Zecic et al. 2006). In Turkish forestry a lot of farm tractors modified for forest operations are used. These tractor are various type and dimension.

Forest machinery production are of various types and dimensions in the

Turkey and forest machines by Turkey forestry are purchased on the foreign market. Forest machines and equipment are usually designed to suit the working conditions of the producer's home country. Therefore, when purchasing these machines and equipment, it is not sufficient to make decision on the basis of factory data and on their productivity referred to in foreign literature (Sabo and Porsinsky 2005).

This paper deals with the research of primary transport of beech timber by farm tractor. The purpose of this research is to give contribution to gaining knowledge of the productivity of a farm tractor in extracting timber from mountainous area in Black Sea region in Turkey.

### Technical Characteristics of New Holland TD85D Farm Tractor

The farm tractor New Holland is a two-wheel drive vehicle. It is modified for skidding timber on strip roads and skid trails, which implies that one end of the dragged timber is in touch with the ground. This



Fig. 1. New Holland TD85D tractor.

tractor is used to slope until average 30%. Tractor New Holland TD85D is modified for work in skidding operations. It is equipped with single drum winch. The cab is well laid out, noise level is minimal, and seats are ergonomically designed (Figure 1). The main technical characteristics of the tractor are shown in Table 1.

**Table 1. Main technical characteristics of the tractor New Holland TD85D.**

Characteristics	New Holland TD85D
Machine power	85 HP
Tractor weight	3700 kg
Number of cylinder	4
Volume of cylinder	3.9 l
Cooling system	Water cooling
Speed – front	35–40 km.hr <sup>-1</sup>
– back	35–40 km.hr <sup>-1</sup>
Type of vinch	Special
Diameter of cable	14 mm
Length of cable	100 m
Speed of cable	40–70 m.min <sup>-1</sup>
Depot capacity	120 l
Average productivity	2.5–5.0 m <sup>3</sup> .hr <sup>-1</sup>

### Research Area

The present research area was located in northern Turkey. The study area is managed by Gurgentepe Forest Office within Ordu Forest Administration (Figure 2). The total area of Gurgentepe Forest Office is 20,031 ha. The information as growing stock and road density are not calculated, yet because this forest office is a new establishment as forest office. The most important commercial tree species in this region are *Picea orientalis* (L.) Link., *Abies nordmanniana* (Stev.) Spach.,

*Fagus orientalis* Lipsky and *Pinus sylvestris* L. The average slope in research area is between 25 and 45%. This tractor was skidding along skid roads in research area. The length and width of skid road are 350 m and 2.5 m, respectively. The type of soil is clay loam.

## Data Collection

Performance and productivity of New Holland tractor was investigated by time and work study method. The productivity works of forestry machines are used time measurements and time study techniques (Klepac and Rummer 2000). Time consumptions of the duration of working components were studied by repetition method and records were taken throughout the whole working day (Ozturk 2010). The distance of skidding was measured by use of a measuring type, the slope gradient of the terrain and strip roads was

measured by clinometer and the load data were collected by measuring the diameter and length of each piece of timber under bark was measured by caliper.

The measurement data were entered into computer files from the record sheets so as to make them available for data processing. Data processing covered the control and selection of data, classification of recorded times and calculation of the achieved work productivity. Statistical data processing was carried out by use of a computer with the application of the software package Microsoft Excel 2003 and SPSS 11.00.

In this study, the impact of the following independent variables to "total cycle time" (total time) were measured. Here the total time is chosen as a dependent variable whereas; "skidding distance", "load volume" and "load number" have been selected as independent variables.

The definitions of both dependent and independent variables and how to measure them are summarized below:

### Dependent variable:

**t = total time**, which is measured as time at scale level variable and the measurement unit is minute.

### Independent variables:

**Sd = skidding distance** which is described as distance between loading point and destination. The distance is measured by meter and marked at regular intervals and recorded.

**Lv = load volume** is a variable that represents

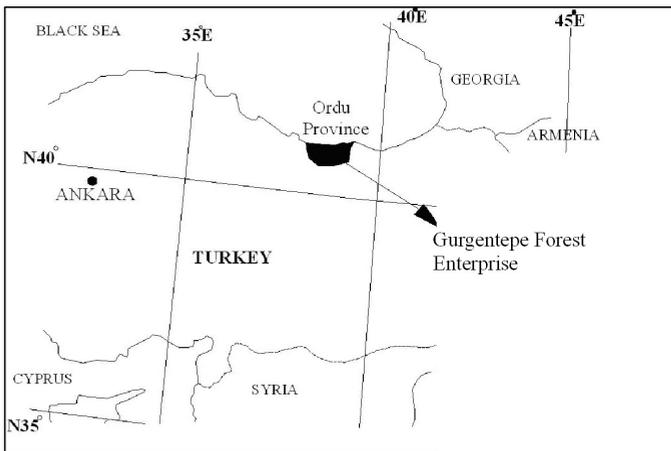


Fig. 2. Ordu province in Turkey.

the volume of all transported logs at the destination. This variable is measured as cubic meters.

**Ln = load number** is a variable that represents the number of all transported logs at the destination. This variable is measured as cubic meters.

All the variables given above are considered as scale variable.

Then, theoretically the mathematical equation like below is obtained:

$$t = a + b + c + d + e + f + Dt + Sd + Lv + Ln.$$

A skidding cycle of tractor is arisen from five phases. These phases are:

**a = unloaded tractor travel**, this phase starts when the tractor is ready to move the loading area. Then, ends of this phase when tractor arrive the loading area.

**b = hookup of load**, it begins at the end of lateral out and ends when the choke setter has completed hooking.

**c = winching**, begins at the end of hookup period and it ends when the operator is skidding timber through tractor side.

**d = loaded tractor travel**, begins at the end of lateral in and ends when the tractor has reached to the ramp.

**e = unhook of load**, begins at the end of in haul when the tractor passes over to the trip block and ends when the hook is pulled back to the loading point.

## Results

SPSS Statistical Software and Excel 2003 were used for skidding the analyses of data. A regression model was developed for the statistical analyses. Initially a 95% significance level was set to test the null

and alternative hypotheses presented above. F-Test and statistically based on a 0.05 significance level statistics were based. The data were consistent with the alternative hypotheses that the proportion of variance in total time, explained by the set of independent variables included in the regression model, was greater than 0.0 in the population from which this sample was selected. It also implied that at least one of these independent variables had a statistically significant effect on total cycle time and that this relationship was linear. The regression model was calculated as follows:

$$t = 9.686 + 0.07.Sd + 0.893.Lv - 0.601.Ln \quad (R^2 = 0.276).$$

In preparing the model for research area, when the other variables were hold constant above, the dependent variables, and the coefficient of Durbin-Watson was 2.502. Since the coefficient was approximately 2 or below, this means that there was no correlation between the independent variables that form the model, and that they were completely separated independent from each other.

The tractor performance was observed at the feeling area for 15 working days. During that time 400 m<sup>3</sup> of timber was extracted in 30 recorded cycles. Timber extraction was carried out at two different distances. The total cycle times of tractor at the distances of 140 and 320 meters are 11.20 and 12.35 minutes, respectively. Average results of measurements are shown Table 2.

The average load volume for 140 and 320 meters skidding distance is 2.150 m<sup>3</sup>. cycle<sup>-1</sup> and 1.620 m<sup>3</sup>.cycle<sup>-1</sup>, respectively. The volumes of an average piece of tim-

Table 2. Average results of measurements.

Skidding distance	Load volume	Load number	Unloaded tractor travel	Hookup of load	Winching	Loaded tractor travel	Unhook of load	Total time
<i>sd</i>	<i>lv</i>	<i>ln</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>t</i>
m	m <sup>3</sup>	number	min / cycle					
140	2.150	2	2.10	2.20	2.30	3.40	0.30	11.20
320	1.620	2	2.50	1.55	3.00	4.10	0.40	12.35

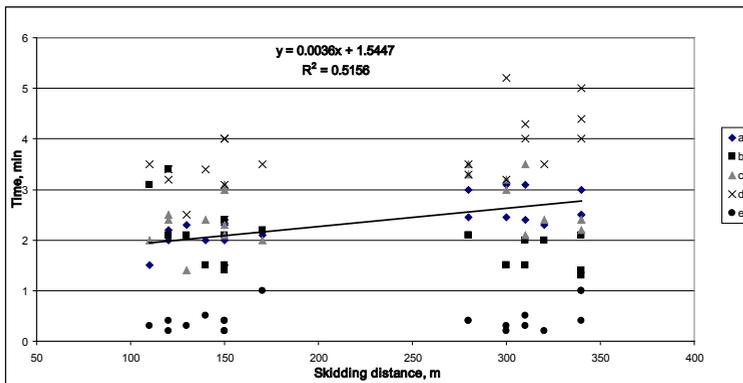


Fig. 3. Relationship of skidding distance vs. total time.

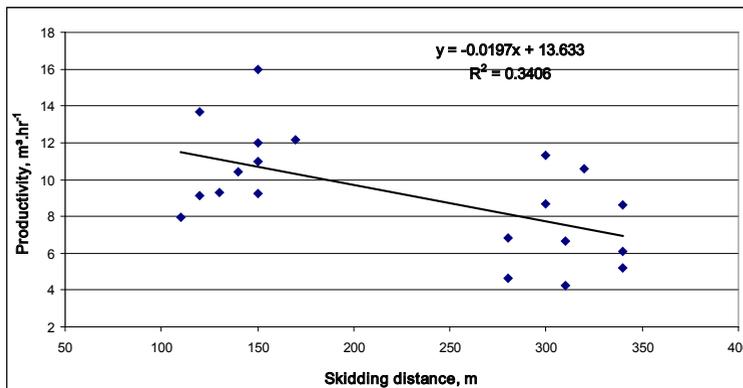


Fig. 4. Relationship of skidding distance vs. productivity.

ber are 1.125 m<sup>3</sup> and 0.810 m<sup>3</sup>. The skidding timber is beech and length of timber is 5 m. The average productivities for different skidding distance at the felling area were 11.350 m<sup>3</sup>.hr<sup>-1</sup> (for 140 m) and 7.700 m<sup>3</sup>.hr<sup>-1</sup> (for 320 m). The average fuel consumption per operating hour was 4.5 l.hr<sup>-1</sup>. The cost of cubic meter of skidding for this felling area are 4.5 \$ and 8.6 \$ for different distances.

The relationship between total time and skidding distance is shown in Figure 3 and the relationship between total time and productivity is shown in Figure 4.

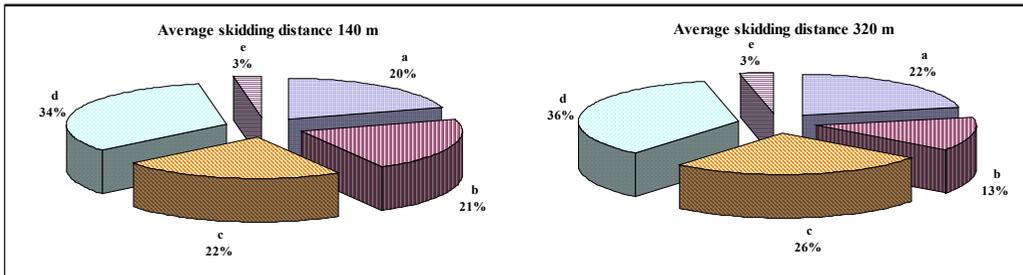


Fig. 5. Percent of work phases.

As shown in Figure 3 and 4, when the skidding distance increases, the total time of a cycle is increasing. In addition, when the skidding distance increases, the productivity of tractor is decreasing. The distribution of time consumption is shown in Figure 5.

This paper shows the results from skidding beech timber by the New Holland tractor. Four forestry workers with an experienced tractor operator were engaged in the skidding operation. The timber skidding was carried out uphill for one skid roads with the slopes of 2% to 12%.

Increasing the average skidding distance during the forest operations decreases the efficiency of machines. At the same time, the cost of skidding increases in felling area. Therefore, in the felling areas forest engineers should use shorter skidding distances. Besides, the skid roads should be coated in the form of a network in production areas.

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