

умовою оптимального вмикання зчеплення, то темп наростання натискної сили dP/dt також практично залишатиметься постійним.

На рис. 2 наведено фрагмент графіка, отриманого під час моделювання процесу зрушення автомобіля КамАЗ-5320 з повним навантаженням ($Q = 80$ кН) на горизонтальній ділянці дороги ($\psi = 0,025$). Для вказаних умов, застосовуючи вищевказаний принцип регулювання натискної сили, отримано такі результати: робота буксування $L_{\delta} = 6520$ Дж, час вмикання зчеплення $t_{\text{вм}} = 1,17$ с, максимальна амплітуда динамічного моменту трансмісії $A_{\text{тр.мах}} = 163$ Н.м, а коефіцієнт динамічності $k_{\delta} = M_{\text{тр.мах}}/M_{e \text{мах}} = 0,66$.

Використовуючи наведену методику можна оптимізувати і розробити технічні засоби для автоматизації процесу вмикання зчеплення будь-якого автомобіля під час зрушення з місця на будь-якій дорозі.

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WORK PERFORMANCE OF MB TRAC 900 TRACTOR ON MOUNTAINS TERRAIN IN TURKEY

The forestry works mainly involves such various stages as growing, protection, production, wood harvesting, marketing and utilization of forest products. Wood harvesting is performed by completion of cutting, extraction and transporting stages. The most obvious feature of wood harvesting is that the operations are done under various weather conditions open in the field. The measurements and observations were made on 25 work made under different working conditions during cable pulling with MB Trac 900 forest tractor at the harvesting area. The time determinations were made with continuous time measuring technique. Regression analyses were employed for determining the factors. In this paper, the results of studies carried out on the MB Trac 900 forest tractor operated in the Artvin region located in the Northeast Turkey are presented.

Keywords: Extraction, Forest tractors, Wood harvesting, MB Trac 900.

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Використання трактора MB TRAC 900 в гірських районах Туреччини

Лісогосподарські роботи включають такі стадії: вирощування лісу, його захист, лісозаготівлю та використання лісової продукції. Під час лісозаготівлі виконуються звалювання, трелювання та транспортування деревини в природних польових умо-

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вах. Спостереження за роботою трактора MB TRAC 900 здійснювались на 25 ділянках. Параметри робочих процесів фіксувалися вимірною технікою в безперервному режимі. На основі регресійного аналізу визначалися коефіцієнти регресії. Наведені результати досліджень роботи трактора MB TRAC 900 в провінції Артвін на північному сході Туреччини.

Ключові слова: трелювання, лісовий трактор, лісозаготівля, MB TRAC 900.

1. Introduction

The transport of forestry products is realized in two stages. The first one is the primary transport stage which involves the haulage of timbers, while the second one is the secondary transport stage involving the main stage of transport of timbers, generally realized by trucks on forest roads [1].

In this study, Taşlıca Forest District is determined as research area. This district depend on Artvin Forestry Operation in Artvin Region Forestry Directorate and have one productivity area.

2. Materials and methods

2.1. Materials

In the district where this study was carried out, the location named Gitancuvar Hill represents the minimum elevation with 1186 m above. Sea level while Kızılkaya Hill the maximum elevation with 1483 m above sea level. The minimum slope was measured to be 10 % while the maximum slope to be 80 %. The road density in the area is 14 m/ha [2].

The studied area for the productivity of a MB Trac 900 was in Taslıca of Artvin. This one area belong to the Artvin province located in Northeast Turkey as shown in Figure 1. The total area of Artvin province is 712 882 ha and 55 % of this area is covered with forests [3]. The major trees species are *Picea orientalis*, *Abies bornmülleriana*, *Pinus sylvestris* and *Fagus orientalis* in forests of Artvin.

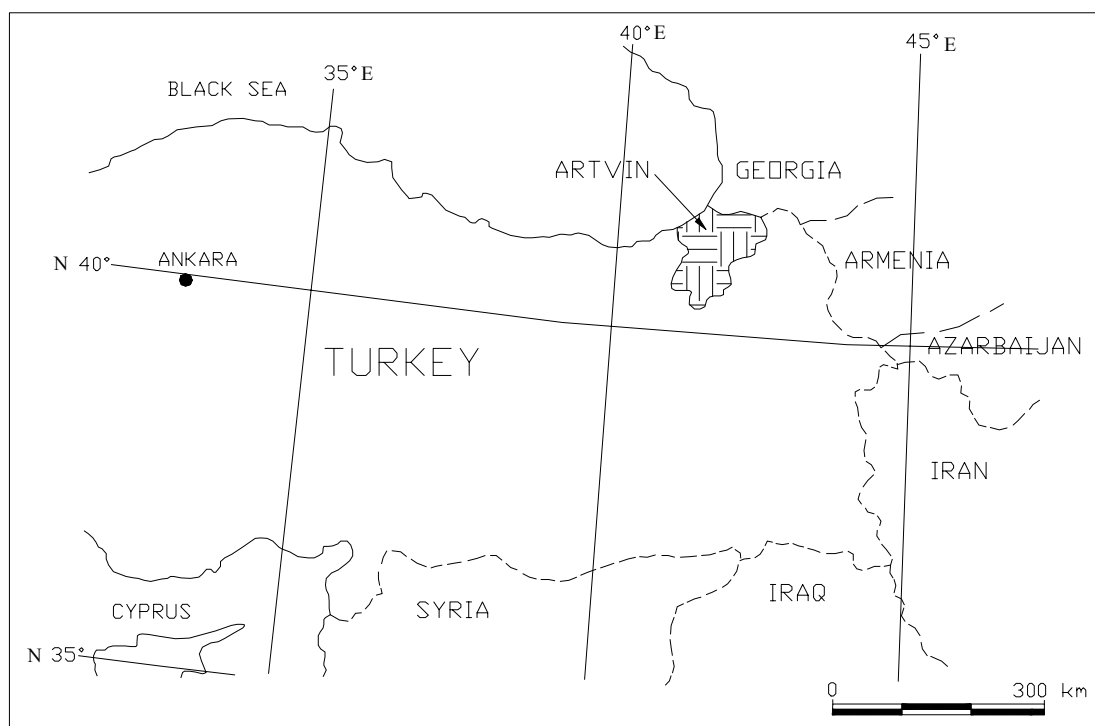


Figure 1. Study area (Artvin province – Turkey)

MB Trac 900 Mercedes tractor with an engine power of 85 HP were used in this study. Technical features of this tractor showed Table 1.

Daily transport capacity of tractor is 40-60 m³ on the average. Drawing rope is 12 mm in thickness and has a length of 100 m. Two workers are employed in operating the tractor.

Table 1. Technical features of MB Trac 900 Tractor [2-4]

Features	MB Trac 900
Machine Power	85 HP (63 kW)
Weight	6000 kg
Drawing Power	2 X 6083 daN
Speed	30/ 40 km/hour
Cylinder	4 cylinder
Cylinder Capacity	3780 cm ³
Cooling System	Water Cooling
Speed - front	25-40 km/hour
Speed - back	20 km/hour
Vinch Mark	CG2M2ZD
Cable Diameter	12 mm
Cable Length	100 m
Cable Speed - 540 tour	33/ 61 m/min
Cable Speed - 1000 tour	19/ 35 m/min
Lift up Power	2000 daN
Depot Capacity	120 lt
Machine Type	OM 314
Output	3.30-8.40 m ³ /hour

Before all else, making the variants analysis in the time measures, measure numbers that are in the level of confidence 95 % are designated enough or not. Than again, the simple and plural regression equations are appeared in the same level of confidence. These are determined the way of maximum correlation coefficient and the minimum error percentage. Findings values are tested with the value of t and the test of F. One of the part of these statistics studies and graphics are made with SPSS 10.0 statistics programme.

2.2. Method

In productive area with the studies of MB Trac 900 is made time measure in order to be appeared the production of machine and to find which factors are effective on these productions. Time measures are made in the productive time of the very dense period of the tractor.

Time measures are made according to the work stages that were determined before with the repetition, the technique of time measure and digital chronometer. Study report card are filled with finding the definite period of time of each work stage. The daily study hour of machine is 8 hours [5].

In order to be made the time studies, tractor's a piece of work for one time are determined in the followings:

- Time required for the tractor to be brought to the place of loading. (S)
- Time required for the loading to be tied to the loading hook (1. Cable) (S-CP)
- Time required for the loading to be tied to the loading hook (2. Cable) (S-CP)
- Time required for drawing the loaded hook (1. Cable) (S-CP)
- Time required for drawing the loaded hook (2. Cable) (S-CP)

- Time required for the tractor to be brought down to the place of unloading. (S)
 - Time required for untying the load from the hook. (S-CP)
 - Total time required. (S-CP)
- (S: Skidding to 300-600 m; CP: Cable Pulling to 30 m)

3. Results and discussion

The Taşlıca District operating under the management of Artvin Forestry Operations office was chosen as the study area for timber haulage operations. All workers employed at tractor operations were housed in the barracks located within the forest area.

In that district, production operations were carried using tractors for a total of 3 months, namely July, August and September during a year, hauling a total of 652 m³ timber. The 90 % of total production realized in the district was transported by the forestry tractors.

The average times of timber haulage for the tractors installed in two different locations in the district are shown in Table 2, while the share of time taken by each stage of operation in the total time is shown in Figure 2.

Table 2. Average Time Investigation of MB Trac 900 Tractor

Run Number	The tractor to be brought to the place of loading (min) a	The loading to be tied to the loading hook (1. Cable) (min) b	The loading to be tied to the loading hook (2. Cable) (min) c	Drawing The loaded hook (1. Cable) (min) d	Drawing The loaded hook (2. Cable) (min) e	The tractor to be brought down to the place of unloading (min) f	Untying the load from the hook (min) g	Total time required (min) h	Amount, Distance of load m ³ / m
Average 600 m Skidding	9.0	3.0	2.0	3.0	4.0	10.0	2.0	33.0	3.498 m ³ 600 m
Average 300 m Skidding	4.0	3.0	3.0	3.0	2.0	4.0	2.0	21.0	3.315 m ³ 300 m
Average 30 m Pulling	--	3.05	2.14	3.05	3.25	--	2.03	13.52	3.256 m ³ 30 m

As a result of measurements and calculations mode during timber haulage operations, the maximum times were found to be required for bringing the loaded wagon up to the place of unloading, and for drawing the loading hook to the loading place to the load. The forestry products hauled were 4-5 m long Spruce and Fir timbers.

This regression model used to stepwise method of SPSS 10 statistical programme. Dependent variable is h (total time) and independent variables are a, b, c, d, e, f, g. R square (R²) has been found 0,980 (98 %). Regreation model is follow;

$$T = 2.812 + 2.015 \cdot f + 1.547 \cdot b + 1.089 \cdot d + 0.715 \cdot c$$

(F = 133.543 and Sig. 0.000).

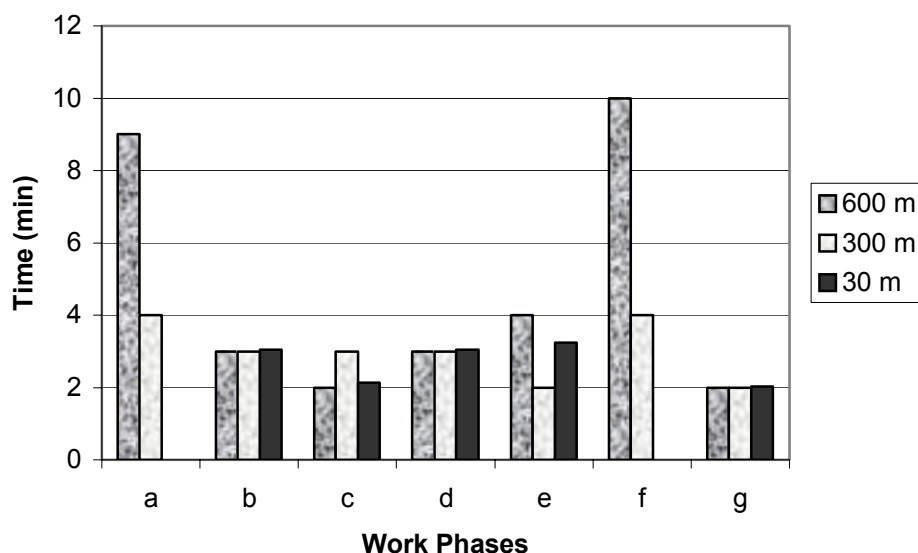


Figure 2. Job Analysis Total Time

As it is shown in the Table 3, The transportation time of MB Trac 900 tractor for average 600 m distance was 33 minutes and for average 300 m distance was 21 minutes. Amount of load for each time was 3,498 m³ and 3.315 m³. This MB Trac 900 tractor's hour product for 600 m distance was 6,360 m³, daily product was calculated as 50,880 m³. Also, for 300 m distance was 9,471 m³ and daily product was 75,768 m³. MB Trac 900 tractor's hour product for average 30 m pulling was 13,954 m³. Average cost per volume of MB 900 Trac is 9,80 \$/m³ (for average 600 m skidding), 7,31 \$/m³ (for average 300 m skidding) and 4,65 \$/m³ (for average 30 m pulling).

Table 3. Data of the MB Trac 900 Tractor

Tractors	Hours Productivite (m ³ /h)	Daily Productivite (m ³ /day)	Fuel (lt/h)	Logging Distance (m)	Average Slope (%)	Average Cost (\$/m ³)
MB 900	6.360	50.880	4.17	600	15	9,80
MB 900	9,471	75,768	3,5	300	13	7,31
MB 900	13,954	111,634	3,0	30	40	4,65

4. Conclusions and recommendations

The results of this study have shown that the transport of forestry products by tractors operated in areas located in mountainous terrain, not accessible by forest roads, is a more permanent and efficient haulage method in mountainous forest land when combined with forest roads, since it enables side drawing, eliminates losses in quality and quantity; offers a comparatively short mounting and dismounting time, has an opening-to-production rate of one hundred percent, and enables transportation in both directions when required.

In the light of the results of this study, the following recommendations should be taken into consideration in order to ensure the performance of timber haulage operations in a more effective and productive way.

For the operation of a tractor in the forest land, there must be an adequate quantity of wood raw materials in the haulage area. The tractor operators must definitely be permanently employed workers. This point is important in order to en-

sure productive working and the careful handling and maintenance of tractors by the operators. For more efficient operation of tractors, a minimum of two workers should be employed at the loading stations. This would enable the tying of hook to the load in a shorter period of time, thereby minimizing any losses of time.

Persons not specialized in tractors operations should not be employed for this purpose as tractors are expensive pieces of equipment and they cannot always be immediately repaired on site.

The Forestry Operations Office must pay special care and attention in providing proper accommodation facilities to the works and meeting their food and tools and equipment needs in order to enable them to work in a more secure and productive way in field conditions. In order to prevent decrease in their efficiency and to reduce fuel consumption, the maintenance of machinery must be performed according to technical specification and in a timely manner. An adequate number of spare parts should be maintained in order to prevent any loss of time in case of urgent maintenance-repair works.

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BIODEGRADABLE OILS USED FOR SAW CHAIN LUBRICATION

Power saws require a relatively large amount of oil for their operation the reason being idle lubrication of the cutting chain. Oil leakages in the environment can result in soil and water contamination and are known to impact both flora and fauna. Many countries in Europe struggle to minimize the damage by imposing the use of biologically degradable oils for these purposes. The work presents an assessment of these biologically degradable oils from the viewpoint of their possible occurrence in environment and from the viewpoint of their technical characteristics which affect reliability and economy of working with power saws. Oil dispersion is evaluated especially from the viewpoint of the concentration of its occurrence on the soil surface after cutting with the power saw. Technical properties evaluated include heat-oxidation stability and pumping properties of oils at low temperatures.

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