

PRODUCTIVITY ANALYSIS OF SKIDDING OPERATIONS WITH FARM TRACTOR ON SKID ROADS: THE CASE OF OSMANIYE FOREST ENTERPRISE CHIEF, TURKEY

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BACKGROUND

- Production of forest products consists of several key activities: felling, delimbing, bucking, logging, loading, hauling, and storing



BACKGROUND

- In Turkey, mechanized logging operations are mostly done by farm tractors
- After some mechanical modification and attachments, farm tractor is used as skidder, loader, forwarder and cableway



BACKGROUND

- In order to determine suitable logging method and select right equipment, productivity of the equipment should be carefully evaluated
- The productivity of the logging equipment or harvesting methods used in the timber extraction operations are generally determined based on the production time
- The most widely used work measurement technique for calculating the production time is time study method

OBJECTIVE

- The aim of this study is to perform the productivity analysis by using time study of the skidding operations carried out with farm tractors on the skid roads



MATERIAL AND METHODS

- The study area was selected from Osmaniye Forest Enterprise located in Adana in Mediterranean region of Turkey
- The field studies were conducted in Brutian pine (*Pinus brutia* Ten.) stands



MATERIAL AND METHODS

- The average ground slope and ground elevation were 35% and 980 meters, respectively
- The average skidding distance and skid road slope were 73 meters and 20%, respectively
- Skidding operations were performed by using 73 – 75 D Turbo 2009 model farm tractor with 75 hp power



MATERIAL AND METHODS

- Work stages evaluated were move-out unloaded, loading in the log, move-in loaded and unloading at the landing
- Time measurement of the work stages were performed for total of 30 trips by using **reset method (repetitive time measurement)** with the help of chronometers
- Statistical analyses of the time measurement were performed using One-Way ANOVA at 0.05 significance level
- Pearson correlation was used to investigate the relation among length, diameter, volume, and skidding distance

MATERIAL AND METHODS

- In order to evaluate the effect of timber volume on productivity, timber volumes were divided into three classes (low (<0.68m³), medium (0.68-1.04 m³), high (>1.04 m³)) according to their volumes
- Timber volume (V in m³) was computed by medium surface approach (Huber Formula), which is widely preferred in technical forestry applications:

$$V_i = \frac{\pi}{40000} d_i^2 L_i$$

- d_i = i medium diameter of the timber (cm)
- L_i = i length of the timber (m)

MATERIAL AND METHODS

- Then, using the data that were obtained by the field measurements, hourly productivity (P in m^3/hour) was computed. Following formula was used for productivity calculations:

$$P = (V / T)$$

V = Timber volume in a cycle (m^3)

T = Total time in a cycle (hour)

60 = Coefficient used for converting minute to hour

RESULTS AND DISCUSSION

Statistical results of productivity variables

Variables	Min.	Max.	Mean	Std. Deviation
Diameter (cm)	23.0	40.00	30.83	5.09
Length (m)	10.0	13.00	11.63	1.00
Volume (m ³)	0.42	1.63	0.91	0.35
Distance (m)	72.0	84.00	79.03	2.76

RESULTS AND DISCUSSION

Statistical results of productivity variables

Work stages	Min.	Max.	Mean	Std. Deviation
Move-out unloaded	1.28	1.35	1.32	0.02
Loading	0.30	0.48	0.38	0.04
Move-in loaded (Skidding)	1.30	3.15	2.10	0.51
Unloading	0.08	0.15	0.11	0.02

According to the results, average skidding time and average total cycle time were determined as 2.10 min and 3.92 min, respectively

RESULTS AND DISCUSSION

Percentage of time spent on each work stage

Work stages	Time (%)
Move-out unloaded	33.67
Loading	9.69
Move-in loaded	53.57
Unloading	3.07

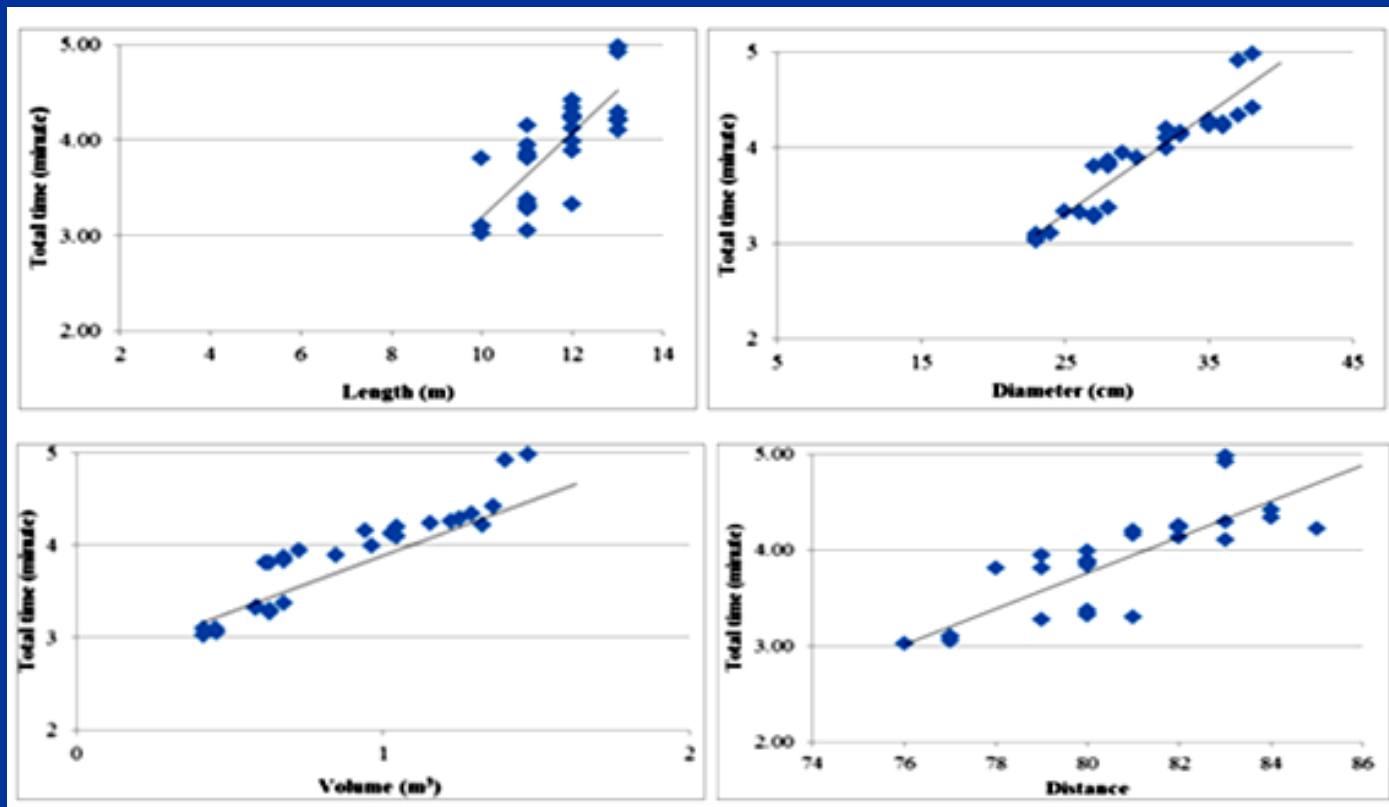
- According to the results, move-in loaded time was the most time-consuming work stage (53.57%)
- The move-out unloaded was found to be the second time-consuming work stage (33.67%), followed by unloading as the least time-consuming work stage (3.07%)

RESULTS AND DISCUSSION

- The results of One-Way ANOVA analysis showed that volume classes of the timber had a significant statistical effect ($p < 0.05$) on the productivity
- The average productivity for the high volume class was found to be greater (17.66 m³/hour) than the medium (13.05 m³/hour) and low (9.78 m³/hour) volume classes

RESULTS AND DISCUSSION

- It was found that the total time increases as length, diameter, volume and distance values increase.
- Similar results were reported by previously conducted time studies during skidding operation in a Brutian pine stands.



CONCLUSIONS

- In this study, skidding operations on skidding roads with farm tractors were evaluated in terms of productivity
- Average productivity of the skidding operations with farm tractor was determined as 13.50 m³/hour
- Statistical analysis suggested that production rate is closely related with timber volume

CONCLUSIONS

- In many regions of Turkey, logging operations are still performed by manual methods relying on animal-human power due to socioeconomic factors
- However, these methods require excessive operation time which minimizes the production rate and adversely affect the quality of harvested timber
- Besides, it is difficult and sometimes impossible to perform manual logging operations in mountainous fields

CONCLUSIONS

- Therefore, small scale logging techniques (i.e. utilizing farm tractors) should be used as an efficient method in timber extraction operations
- In current conditions, modified farm tractors can be equipped with necessary logging attachments with reasonable investment which can be afforded by the small size enterprises and even by individual contractors



Thank you

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