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THE PRODUCTIVITY OF KOLLER K300 YARDER IN TURKISH FORESTRY

Forests have become more and more important sustainable sources in the world. Due to the excessively demands for wood raw material, in the harvesting process, it is obligatory to obtain of wood without to suffer losses in that perspective of qualitative and quantitative.

There are also two stages in the transportation of forest products. The first one is to transport the products from the place where it was originally cut down to the main storage area, better known as transportation of wood raw materials from forest compartment, the second one is to transport the products from the stacked or main storage areas to trading storage and factories.

This study on effects of time and other active factors on the forest transportation of harvested wood raw materials from forest compartments by using Koller K300 skyline took place in Artvin district forests during the summer months. Work conditions of timber logging by Koller K300 Skyline and their effects on productivity were investigated. For this purpose, work conditions were studied in the harvesting areas. In addition, real times of work phases, total travel time and lose time were determined by continuously time measurement technique with chronometer. Data obtained from harvesting areas was statistically evaluated and the factors that effected, on total study time were determined.

Softwood timbers (*Abies nordmanniana* and *Picea orientalis*) were transported by Koller K300 skyline towards uphill. Daily productivity of Koller K300 was determined as 36.184 m³/day for 280 m distance and 55 % skyline slope.

The results of the variable factors affecting the working time sections of Koller K300 skyline systems shown in this study can be used in Artvin district or areas showing the same characteristics. They can also be used for preparing annual production plans and skyline working programs and for monitoring and controlling the plans when applied in the practise.

Keywords: Koller K300 Skyline, Logging, Steep Terrain, Turkish Forestry.

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Використання мобільного линвового обладнання "KOLLER K300" в лісовому господарстві Туреччини

З кожним роком попит на деревину зростає. Це ставить нові, кількісні та якісні вимоги до лісозаготівельних процесів.

Існує дві ступені транспортування лісової продукції: з лісосіки – на верхній склад та з верхнього складу до споживача. У статті досліджується ефективність використання на транспортуванні деревини до верхнього складу мобільного линвового обладнання KOLLER K300 в лісах Артвінського району в літній час. Для цієї мети у польових умовах визначалися реальні тривалості елементів робочого циклу мобільного линвового обладнання, повний час транспортування і втрати часу, викликані простоюванням технічного засобу. У подальшому виконувався статистичний аналіз отриманих результатів.

Денна продуктивність мобільного линвового обладнання KOLLER K300 під час транспортування деревини м'яких порід на відстань 280 м з ухилом 55 % становила 36,184 м³/день. Отримані статистичні дані можуть бути використані для складання річних планів, контролю та моніторингу роботи мобільного линвового обладнання.

Ключові слова: мобільне линвове обладнання KOLLER K300, лісозаготівля, стрімкі схили, лісове господарство Туреччини.

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1. Introduction

The high demands for timber, terrain using of without planning, exceptional legal regulations in the forest law and grazing caused to drawing of forests to mountainous terrain, where applying of forestry activities are heavy and quite costly. In steep terrain forestry, such complex condition of those areas planning of work and the control of those is quite difficult.

Skylines usage, with the technological developments in the world, has become more and more important because of difficulties in extraction of wood production in the countries that have steep terrain conditions. In this stage, rationalization efforts to extract wood raw material from stand decrease the cost of harvesting operation. In timber extraction phase, the first step of timber transportation that is called primer transport, using of skylines reduces the damages originated from harvesting operations (Çağlar, Karaman, Acar, 2003).

In Turkey, about 27 percent (20.7 million hectare) of total area is covered the forests and other wooded land. These areas' 48 percent are productive forestland. Total productive forests have 1 032 740 659 m³ timber volume (Ministry of Forestry, 2000). The total forestland, 99.9 % of which is belong to State.

Applying of skyline, short-medium-long distance, was started after end of 1970's in Turkey. The most favorable using areas of the skylines are mountainous Eastern Black sea Region of Turkey (Aykut, Acar, Şentürk, 1997). The sledge skylines were used in the logging operations for the first time in Turkey. The sledge skylines which were Wyssen, Baco and Hinteregger generally were used in East Black Sea Region forests.

Artvin, a sample of steep terrain structure in Eastern Black-Sea Region, was selected as a study area. Artvin forest district has total 1 343 074 hectare forest lands. 82 percent of these areas are productive forest. In that forest area, Artvin region has 6.6 percent part of total Turkey forest areas. Average timber volume of these areas is 93 m³ per hectare (Acar, Gümü, 2000). In a study was found field slope of these forest areas was ranged from 51 % to 75 % (Erdaş, Acar, 1995).

By means of Koller K300 short distance cable crane, a study is made for three different areas in Artvin. The productivity was determined as 5.151 m³/hour for 300 m distance and 45 % slope, 6.270 m³/hour for 220 m distance and 64 % slope, and 6.256 m³/hour for 290 m distance and 40 % slope, respectively (Öztürk, 1996). A study was made by using Koller K300 in Austria, the productivity of skyline mainly depends on distance, dragging from side and number of pieces. In this study, it was stated that the productivity wasn't affected by volume of timbers (Erdaş 1989).

The productivity of Koller K300 in a study conducted in Artvin was found 4.997 m³/hour for transportation of soft wood, 4.755 m³/hour for transportation of hard wood and 6.88 ster/hours for transportation of fuel-wood (Eroğlu, 1997). In Eastern Black Sea Region of Turkey by using of Koller K300 short distance skyline hardwood transported. The work productivity was obtained 12.19 m³/hour for 163 m. and 28 % skyline slope (Aykut, Acar, Şentürk, 1997). In another study, conducted in mountainous Artvin region, softwood transported. The productivity was found 3.750 m³/hour for 250 m long distance by using Koller K300 skyline (Erdaş, Acar, 1995).

2. Material and Method

2.1. Material

This investigation was conducted in Artvin forest district located in Mountainous Eastern Black Sea Region by means of Koller K300 short distance skyline. The study area located in Ardauç Directorate of State Forest Enterprise, Karanlıkmeşe Forest District.

Koller K300 mobile skyline was imported in 1982 and this skyline commonly have been used in logging operation in Turkey. For this reason, working conditions of Koller K300 skyline were examined and its productivity was determined.



Figure 1. Logging Area and Koller K300 Mobile skyline

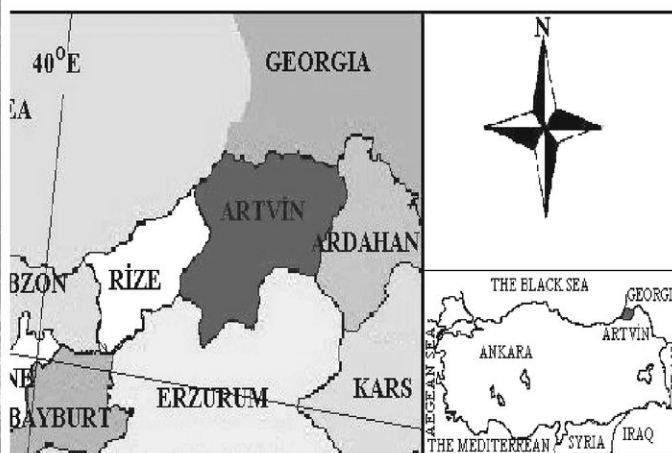


Figure 2. Geographic Information About Study Area (Artvin)

Mobile yarders have winch drums, towers and other auxiliary equipment mounted on wheeled or tracklaying chassis. A mobile yarder may be a trailer or self propelled. The yarder equipment is often mounted on a tractor or a truck. A cable crane for uphill yarding does not need a haul-back line if the slope is steeper than approximately 20 %. The carriage returns from landing to logging area by gravity (Samset 1985).

The Koller K 300 is mounted on the 3-point link of 50 kW farm-tractor (Figure 1). This machine is produced by an Austrian company. Tractor mounted Koller K300 forest skyline transports from the down to up sides. The mobile skylines can be used in low sloped areas. The carriage goes down empty from uphill to downhill in sloped areas due to gravity and comes back by means of engine power. The transport distance is dependent on drum capacity and cable diameter.

Working conditions and establishment information belonging to study area has given below Table 1 as briefly. With determination of working time data and some effective factors productivity values were obtained for given condition.

Altimeter, camera, klizimeter, kronometer, compass, meter, and other auxiliary tools were used for this study. In addition, maps which is scaled 1/25000, ma-

management plans, silviculture plan and data related harvest activities obtained from the state forest district in study area.

Table 1. Working Conditions and Establishment Information of Koller K300 Skyline (Çağlar, 2002)

Working conditions and establishment information		Koller K300
Length of Cable (m)		350
Number of Support		—
Field slope (%)		78
Height of skyline (m)		18
Slope of skyline (%)		55
Average dragging from side (m)		23
Hauling Distance	Hanging (m)	255
	Suspending (m)	25
Transportation direction		From downhill to uphill
Transported tree species (log)		Fir (Abies), Spruce (Picea)
Number of workers	U.S + D.S	2 + 1
	Operator + Opr. Assist.	1 + 0
Measured number of shift		57

US: Up Station, DS: Down Station

2.2. Method

The research methodology used for all time studies conducted during cable logging activities was cumulative timing exclusively, with the time for each work phase obtained by extraction. The subjects of observation were the short distance skyline operations, which were carried out by winch operator. It was also recorded that the time period such as lunch and the other consuming time, etc.,. As a result, data was collected to support the analysis of time consumption and the evaluation of time distribution of work phases.

Table 2. Dependent Time Variables and Independent Variables for Each Cycle

Dependent time variables	Independent variables
y ₁ : Hauling back of empty carriage,	x ₁ : Dragging from side distance,
y ₂ : Descending of bundle hook,	x ₂ : Number of piece,
y ₃ : Pulling of hook to log and attaching of loads	x ₃ : Average log diameter,
y ₄ : Pulling of loaded hook to carriage	x ₄ : Average log length,
y ₅ : Moving of loaded carriage to landing site,	x ₅ : Log volume (for each shift)
y ₆ : Descending of loaded hook to ground,	
y ₇ : Unhooking of loads,	
y ₈ : Pulling backwards of empty hook,	
y ₉ : Nonworking time (such as spare, delay and other times)	
Y _{st} : Average shift time	

Independent variables effecting on the working time and dependent time variables were shown as x_{ii} and y_{ii}, respectively. In this study, one minute (60 seconds) was assumed to be 100 and all the other calculations were done accordingly. Obtained data of time consumption and observations were evaluated by SPSS Statistical software package. Analysis of Step-Wise Regression and Bivariate Correlate were used to find the best model. In conclusion, the most effective work phases were determined for total work time and productivity.

Since the goal of the cable crane operation is to collect the logs (timbers) from the logging area and transport it to a terminal point, the landing, each of the loads is a result of several work phases. The series of work phases for short distance skyline activities at logging place constitutes the work cycle. Explanation of work cycle is given below:

3. Results and Discussion

Work phases for transportation of prepared logs from compartment by using Koller K300 were measured and their average values were calculated. Work phases and their percentages in average shift time consumption were calculated. It was shown in Table 3 and Figure 3.

Table 3. Work Phases and Their Percentages in Average Shift Time Consumption

Sledge Winch Skyline	Work Phases (1/100 minute)									
	Y ₁ (%)	Y ₂ (%)	Y ₃ (%)	Y ₄ (%)	Y ₅ (%)	Y ₆ (%)	Y ₇ (%)	Y ₈ (%)	Y ₉ (%)	Y _{st} (%)
Time consumption	64 (3.8)	47 (2.8)	573 (33.9)	261 (15.4)	401 (23.7)	28 (1.7)	92 (5.4)	15 (0.9)	209 (12.4)	1690 (100)

Working place and work phases to get higher productive extraction from the compartment in less time can be done some rational organizations. The most effective work phases times for average shift (journey) time and their effects can be reduced. In this study for Koller K300 mobile skyline, distribution of work phases in average shift (journey) time was determined as $y_3 > y_5 > y_4 > y_9 > y_7 > y_1 > y_2 > y_6 > y_8$. As shown Figure 3. the most effective phase in average shift time is the phase "Pulling of hook to log and attaching of loads" (y_3).

For Koller K300 mobile short distance skyline, it was found that there was a positive correlation between y_3 , y_9 and y_{st} at 99 % significant level. In addition, the same result was found for y_5 at 95 % significant level.

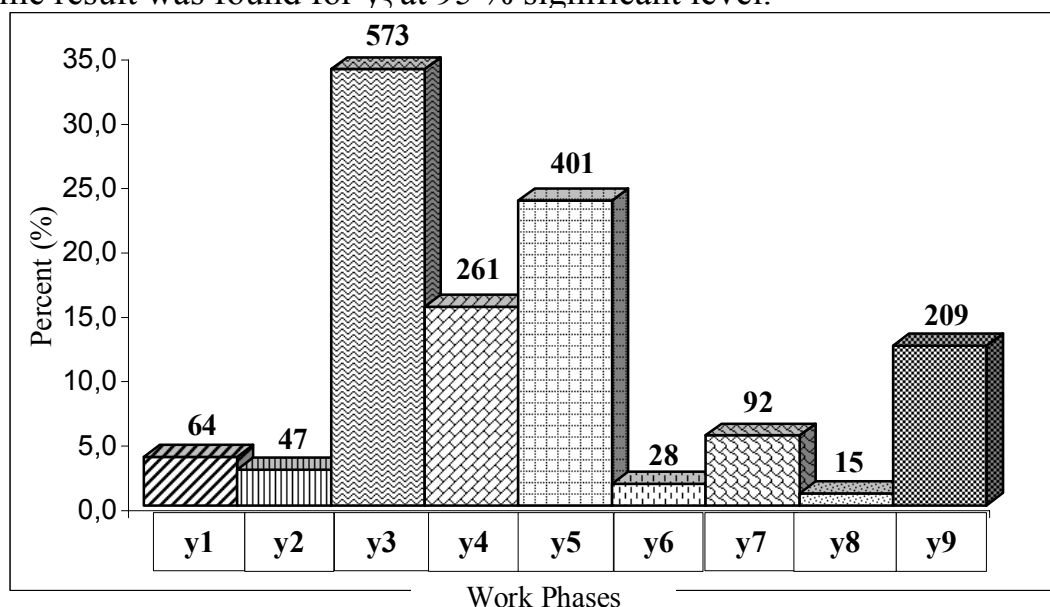


Figure 3. Work Phase and Their Percentages in Average Shift Time Obtained from Koller K300

For extraction from the compartment by Koller K300 mobile skyline, it wasn't found a significant regression model for "average shift time (Y_{st})". The best model was determined for "Pulling of loaded hook to carriage (y_4)" and is given as follows:

$$y_4 = -232.87 + 21.26x_1 (R^2 = 0.522 \text{ SE} = 124.04).$$

It was found that there was a positive correlation between x_1 and y_2 , x_5 and y_5 , x_2 and y_7 at 95 % significant level, while there was a positive correlation between x_3 and y_3 , x_1 and y_4 , x_3 and y_3 , x_4 and y_8 , x_5 and y_{st} at 99 % significant level.

The production, the productivity and the labour consumption for the various cable cranes depend on the terrain conditions and tree dimensions and big variations in productivity values exist (Samset 1985). Productivities of Koller K300 and average shift times were calculated as shown in Table 4.

Table 4. Average Productivity and Shift Time Values of Koller K 300 Mobile Skyline.

Mobile Winch Skyline		Koller K300
Average shift time (1/100 minute)		1690
Average number of piece (Piece/shift)		1.9
Skyline Productivity	m ³ /shift	1.274
	m ³ /hour	4.523
	m ³ /day	36.184

Usually the productivity for uphill cable crane yading is 15-25 % higher than downhill yading. The daily production also depends on the length of a working day (Samset 1985).

4. Conclusion and Recommendations

In this study, softwood timbers (*Abies nordmanniana* and *Picea orientalis*) were transported from the compartment by using Koller K300 short distance mobile skyline. Average shift time for uphill transportation was found 1690 minute/shift. In addition, productivity of Koller K300 skyline was found 1.274 m³/shift, 4.523 m³/hour. Daily productivity of Koller K300 was determined as 36.184 m³/day for 280 m distance and 55 % skyline slope.

Generally in this study the time consumption depends on machine power, operator and worker experience, number of piece and size, weigh and volume of pieces, ground slope, and the other effective factors. Some of work elements namely (y_1 , y_2 , y_5 , y_6 , y_8) for every different journey approximately equal to initial work phases in same construction place of sledge skylines. In other words, the standard deviations of those each variable were found to be very small. However, other work phases (y_3 , y_4 , y_7) different from the initial ones for each journey.

The short distance cable crane such as Koller K300 needs a well designed and developed road networks. However, the effects of Koller K300 mobile skyline on the environment and productivity were found to be positive. To shorten total work time and to prevent the harvesting damages, applying of skyline is very ideally. If the timbers have been transported by using the skidding method on the ground, it would have been no economical, and very harmful for forest ecosystem.

Generally to shorten total work time of work phase, to increase the work and worker productivity, to reduce the damages, for safely work activities, to expand using of skyline where suitable area, and for environmental aspects can be proposed as below:

- The results of this study can be used for annual harvesting planning, work force planning and the plan control in similar geographical areas in summer days logging operation.

- Harvesting plan, felling plan and felling direction must be determined and work organization must be done before the logging operation. A good coordination between the felling, cutting and yarding gives increased production.
- Selecting the unloading place should be very well so that the stocked logs on the side of forest road must not obstruct extraction activities, the road traffic and other activities.
- The cutters should be instructed in directional felling and all logging staff should be informed about first aid precautions.
- Environmental sensitivity, safely work activities and productivity should be taken as a top priority while planning, renting and installation the skylines.
- The short distance mobile yarders require well developed and designed road network, so this subject should be taken into consideration while the transportation plan is planning.
- The skylines must be repaired before set up and their spare parts should always be prepared. To set up the mobile skyline, professional experts must be employed who is educated in skyline. Before setting up skylines, the logs must be checked whether they are prepared or not. At last, the best route must be selected to transport maximum raw wood material.
- The time analysis of forest skyline should be done in different logging area. Taking into consideration the most effective work phases on the total working time, with work arrangement, loading sufficient load, preparing of load, maintenance and repair.

The staff problem should be solved to increase of workers' productivity success. Workers' camping, nutrition and safely working condition should be provided. The operators should repair the skylines in winter months and they should be informed about working technique with the skylines out of harvesting times. A better work plan should be made. Operator and a supervisor who will be selected workers should be authorized to applications of the work plan and to organization of workers.

The short distance mobile skylines should be combined with long distance sledge skyline and other harvesting machines. The skylines must not be waited to prepare the load.

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НОВИЙ НАПРЯМОК ВИКОРИСТАННЯ ЗЕЛЕНІ ЛИСТЯНИХ ПОРІД ДЕРЕВ У ЛІСОВИХ ГОСПОДАРСТВАХ УКРАЇНИ

Висвітлюються питання використання зелені листяних порід для вигодівлі мон-вольтинної породи дубового шовкопряда "Поліський тасар".

Ключові слова: листя дерев, використання, дубовий шовкопряд.

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The New Direct of Utilization of Deciduous Trees' Greenery in Ukraine's Forestry Economies

Use of breeding of deciduous trees for cultivation oak silkworm "Tassar of Polissya" is considered.

Keywords: trees leaves, utilization, oak silkworm.

Комплексне використання лісу як екосистеми є метою і завданням вчених і працівників лісових господарств. Широко розповсюджена заготівля не тільки деревини, але й соснової живиці, ягід, грибів, лікарських рослин, виробництво ефірних масел, хвойних лікувальних екстрактів, хвойно-вітамінного борошна тощо.

Новим напрямком використання лісових ресурсів є вирощування мон-вольтинної породи дубового шовкопряда Поліський тасар, технологія якого дала змогу вигодовувати корисних комах листям, яке залишається під час рубок головного й проміжного лісокористування, а також від інших лісозаготівельних робіт. При вирощуванні гусені шовкопряда можливо використовувати деревну зелень не тільки дуба черешкового, але й ряду інших листяних порід – бука європейського, граба звичайного, берези бородавчастої, верби сірої.

Технологія вирощування дубового шовкопряда в інсектаріях легкого типу під поліетиленовою плівкою пройшла виробничу перевірку на території Волинської, Рівненської, Тернопільської, Івано-Франківської та Хмельницької областей України.

З метою створення гарантійного кормового резерву для гусені літньо-осінніх вигодівель, а також максимального збереження його поживної цінності розроблена технологія консервування листя кормових рослин. Найбільш ефективну консервуючу дію на листову масу чинять хімічний (бензойна кислота) та біологічний (кормові дріжджі) консерванти корму. Ці речовини в рекомен-

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