
(:)

*

(// : // :)

Archive of SID

()
/ / () ()
/ /

:

()

:

:

()
()

()

:

()

/ m³/ha

()

/ /

()

Archive of SID

()

()

()



() × ()
() cm () ×

()

()

Archive of SID

()

v

...

()

$$n = \frac{t^2 \times s^2}{E^2}$$

()

t

=t =n

=S

=E

() ()

SPSS

Archive of SID

Normal plots
Anderson- Darling
Stepwise Regression

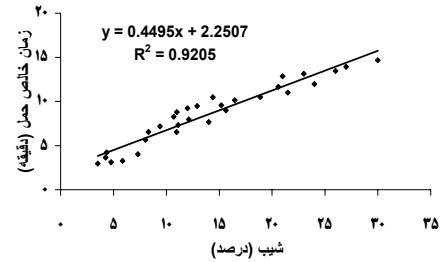
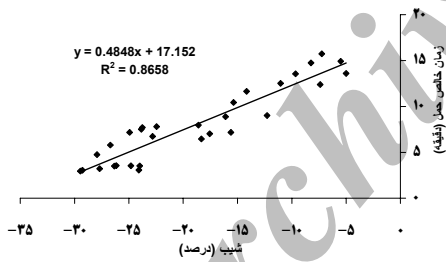
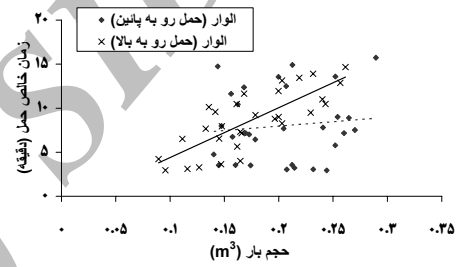
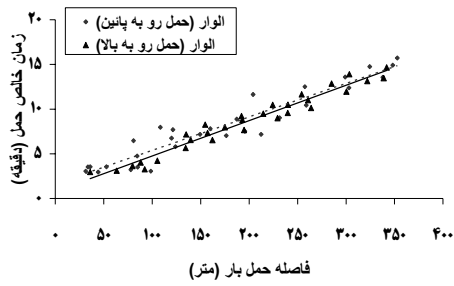
Outhaul time
Hook time
Inhaul time
Unhook time

()

:

()

()



() =T

() =D

() =V

:

$$T = - / + / D + / V$$

...

				$F = \frac{MSK}{MSe}$	() R^2	P
		/	/	/	/	/
		/	/			
		/				

T= / + / D+ / S×V

F

() : $\alpha = 0/01$
 =T R^2 /
 =D ()
 =SV

)

(

				$F = \frac{MSK}{MSe}$	() R^2	P
		/	/	/	/	/
		/	/			
		/				

F

SPSS

$\alpha = 0/01$
 /

Archive of SID

()

$$\text{میزان حمل} = \frac{(\quad)}{(\quad)}$$

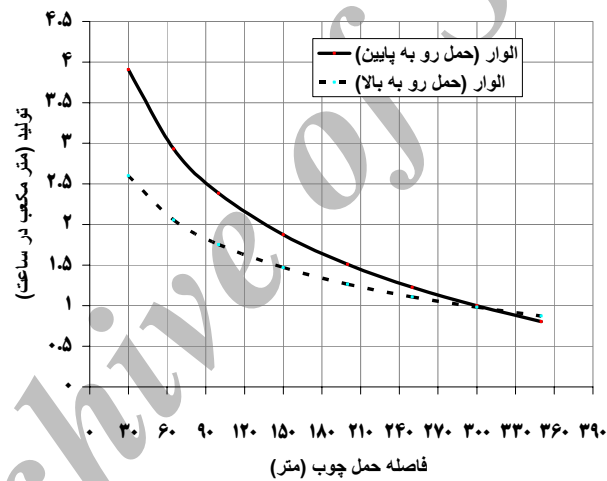
()

()

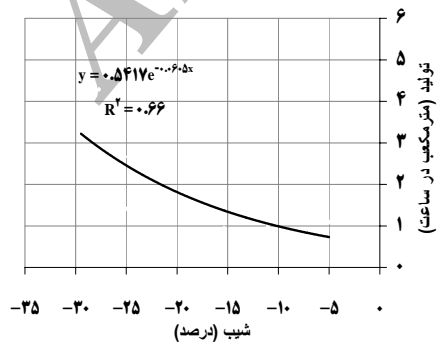
/ /

() / /

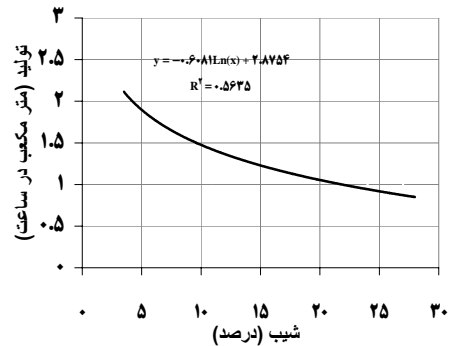
()



()



()



()

...

:
.[]

$$\frac{\left(\frac{\text{هزینه سیستم (ریال / ساعت)}}{\text{میزان تولید (متر مکعب / ساعت)}} \right)}{\left(\frac{\text{}}{\text{}} \right)} = \left(\frac{\text{}}{\text{}} \right)$$

Archive of SID

Mule hauling cost

Animal Rate

()

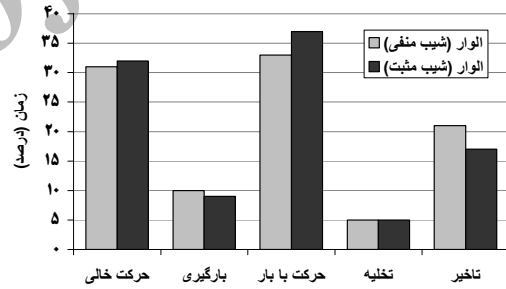
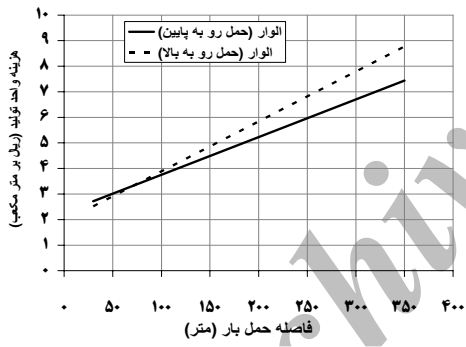
$$C = \dots + \dots / D$$

$$C = \dots + \dots / D$$

=C

=D *

()



()

A

()

()

()

...

(Hauling)

(skidding)

()) (

Archive of SID

-
- ()
- 4- Akay, Abdullah E. 2005. Determining Cost and Productivity of Using Animals in Forest Harvesting Operations. *Journal of Applied Sciences Research* 1(2): 190-195.
 - 5- Heinrich, R. 1985. Medium technology in wood harvesting. Logging and transport in steep terrain. FAO, Rome. 46 pp.
 - 6- McCabe, P.P. and E. Tiner. 1992. Mule logging: A dying art? *Treasures Forest*, spring 1992, pp14-15.
 - 7- Oskarshamn, T.A. B.P. 1983. Extraction using draught animals. Technical field note3. *Swedish Forestry Technique with Possible Applications in the Third World*. 16 pp.
 - 8- Rodriguez, E.O. and A.M. Fellow. 1986. Wood extraction with oxen and agricultural tractors. FAO Forestry Paper No. 49. 92 pp.
 - 9- Shrestha S. P. and Bobby L. Lanford. 2005. Utilization and Cost of Log Production from Animal Logging Operations. *Journal of Forest Engineering* 16(2): 167-180
 - 10- Thompson, M.A. and J.A. Sturos. 1984. Bunching with low-investment systems in northern hardwood pole thinning. American Society of Agricultural Engineers. Paper No. 84-1599. 32 pp.
 - 11- Wang, L. 1997. Assessment of animal skidding and ground machine skidding under mountain condition. *Journal of Forest Engineering* 8(2):57-64.
 - 12- Wang, L. 1999. Environmentally Sound Timber Extracting Techniques for small tree Harvesting. Presentation at the 1999 ASAE Annual International Meeting Sponsored by ASAE. Toronto. Canada. 7 pp.

Evaluation of production and costs of mule logging in down and up slopes (Case study: Kheirood forest)

M. Jour Gholami^{*1}, B. Majnounian², M. Zobeiri³ and J. Fegghi⁴

¹ Ph.D. student of Forestry, Faculty of Natural Resources, University of Tehran, I. R. Iran

² Associate prof, Faculty of Natural Resources, University of Tehran, I. R. Iran

³ Professor, Faculty of Natural Resources, University of Tehran, I. R. Iran

⁴ Assistant prof, Faculty of Natural Resources, University of Tehran, I. R. Iran

(Received: 14 October 2007, Accepted: 21 April 2008)

Abstract

In north of Iran, the animal logging in Hyrcanian forest is a traditional method over past decades. Recently, with increasing environmental interest, concentration on environmentally sound timber extraction and small scale tree harvesting, the proportion of mule logging was increased in Caspian forest. The objective of this study is to develop a standard unified method of data collection to be used to improve the efficiency of mule logging operations and improve the quality of hauling cost and productivity information available for use in forest management plans and decisions. An environmentally sound timber extraction technique for small tree harvesting, particularly for thinning operations, were presented and introduced in this paper. The research was carried out in 213 compartment of Namkhaneh district, in Kheirood forest. Two types mule logging crews working in Kheirood during the study period were selected as the sample for this study: 1) Mules for lumber hauling in downhill, 2) Mules for lumber hauling in uphill. Time per turn for hauling of lumber in down and up slopes averaged 8 and 8.6 minutes, respectively. Regression models were developed for production-related elements with variance analysis using SPSS software. The hourly production of hauling with mule (m^3/h) with delay time, for hauling of lumber in uphill and downhill were 1.00 & 1.2 m^3/h , respectively and without delay time were 1.21 & 1.5 m^3/h , respectively. The result showed that production of lumber in down slope was greater than production of lumber in uphill. In addition, mule rate or hourly cost of mule hauling system in productive mule hour was 57982 Rials/h. As a consequence, the changes of hauling costs showed that increasing hauling distances variable on lumber hauling caused to linear increase in cost.

Keywords: Mule hauling, Time study, Lumber, Downhill, Uphill, Regression model, Animal rate.

* Corresponding author: Tel: +98 261 2249310 , Fax: +98 261 2249310 E-mail: jgholami@nrf.ut.ac.ir