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Evaluation of Production and Cost of Extraction in Tree Length Logging Operation

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Abstract

This study examines the production and cost of exploitation of Teda species in tree length logging method in the west of Guilan province- northern Iran. In order to determine the amount of production and cost in unit of production in transportation stage, work study method was used. The results showed that the hourly production taking into account the delay time and without considering the delay time was calculated 11 and 12 cubic meters per hour respectively. The cost calculated for the skidding system showed that the hourly cost production taking into account productive and scheduled time was 974366 and 945947 Rials per hour. Calculating the cost of extracting without delay time and with delay time showed that they were 81197 and 88957 Rials per cubic meter. The study of the costs in cutting and transportation showed that due to the higher price of products in the market, production of these products is economical.

Keywords: Hourly cost, Hourly production, Pine forest plantation, Time study, Tree length method

Introduction

Wood extraction from forest to the roadside landing is the most expensive phase of harvesting system and loading works as a link between primary transportation and secondary transportation. Since it has important influence on the productivity of harvesting, it is called bottleneck (Conway 1979).

There are many different reports on determining road construction and skidding costs of different logging method. Forest harvesting costs account for more than half of the cost of forest management unit and in Iran; it sometimes reaches 65 percent (Sarikhani, 1990). So it is very important to optimize the related harvesting costs in any forest management activities. At present forests administrators are concerned with these issues and try to find suitable approaches to reduce costs and increase efficiency.

In most studies carried out on the evaluation of systems efficiency and operation of harvesting machinery the time study techniques and statistical models were used for estimating time and cost of operation. One of the

principles in this method is to divide the work into work elements which allows for a more precise study and also separates productive time and unproductive time (Bjorheden, 1991).

So it could be said that typical work study methods for studying the harvesting system have been time study and method study, in combination with measures of the production (Ovaskainen 2009; Bagheri, & Naghdi, 2009). Time study is one of the most common practices of work measurements (Björheden 1991). Time study is defined as the analysis of the methods, material, tools and equipment used in the production process (Gonzáles 2005). The conditions of performing the time study should be as equal to the normal forest work. A time study is usually done either as a comparative study, a correlation study or a combination of the two (Gonzáles 2005; Naghdi & Ghajar 2012). The objective of comparative studies is to compare two or more machines, work methods while the objective of the correlation study is to describe the relationship between performance and the factor influencing the work (Samset 1990).

The usual way to compare work methods and machines is through cost calculation. These are also needed when adjusting piece rate and contracting payments and when monitoring operations. An important application of cost calculation is in the estimation of the most economic replacement schedule for a machine.

Ledoux and Huyler (2001) compared large cut to length and small cut to length system of harvesting in terms of production and operating costs with different machine utilization rates in broad leave forests of eastern USA. In their research they used time study method and examined the effective factors in

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extracting logs from feeling gaps to landings on the side of road. They concluded that the most important effective factors were load volume in each turn, skidding distance and number of logs in each turn. The logging method is one of the important factors in determining type of roads and road network density (Lotfalian, 2001).Forest roads network are different in terms of technical specification with regards to topographical situation of the area, logging methods, type of machinery and length of logs. Therefore the roads construction and maintenance costs will be different. Construction and maintenance costs of roads are the main costs that directly affect road network density. On the other hand silvicultural system with regards to production output determines type of logging machinery and forest road network density (Naghdi, 2004; Ghaffariyan et al 2012).

Materials and Methods

In this study, in order to determine the amount of production and the cost of unit in production during the logging stage work study method was employed. The work study involves the timing techniques and the study of the method. For this purpose, at first, the entire work cycle was divided into the main components (elements of work) and in the next step a digital camera was used for timing. After completing the work and revising the film, the time spent on each component was calculated with a precision of one hundredth of a second and extracted separately. In addition to these times, technical and personal delays calculated individually for each step. All of these studies were done by random sampling method. In random sampling to determine the required number of samples, a preliminary inventory was first used to determine the variance of the work time without taking into account the delay time. Using equation (1) the number of samples needed to calculate the time has been calculated. To construct the model, the variables that were thought to affect the amount of function (production) were used. If the entry of a variable has a significant effect on the model, that will enter the model. The stationary regression technique was used to determine the variable and constant coefficients of the model. In order to calculate the costs in the studied area, the proposed guidelines for the preparation of a plan for exploitation of the forestry and pasture and water management organization of the Iran that was extracted from the FAO guidelines were used. Equation (2) was used to estimate the unit cost of production.

$$\mathbf{n} = \frac{t^2 \times sx\%^2}{E\%^2} \qquad \text{(Equation 1)}$$

$$C = \frac{\frac{V \times (t + Dt)}{v} \times SC}{V} \qquad \text{(Equation 2)}$$

C is unit production cost, Dt is average delay time at one time (hours), V is total volume of sawdust (cubic meter), t average time of one hour (hours), v is average volume of wood in one turn (cubic meters) and SC is system cost (Rials per hour) in equation 2.

Results and Discussion

The mathematical model to predict skidding time

In this research, the most important probabilistic factors affecting the time of skidding, such as skidding distance, load volume, number per turn, were measured. The information and resources regarding to exploitation show that the most suitable and best form of the preparation of mathematical models for the work time with machine is analysis of variance and the preparation of multivariate regression models. After entering the data in SPSS software and ensuring their normalization (using Smirnov's Kolmogorov test), stepwise regression was used for fitting the model and then model was created using the entered variables. This model is a function of independent variables of number of trunk, skidding distance and volume that had the greatest impact during skidding times (Equation 3).

$$Y = -0.829 + 0.898\mathbf{N} + 0.018D + 2.210\mathbf{V} \qquad \text{(Equation 3)}$$

Y= skidding time, N = number of trunk, D = skidding distance (m), V = volume (m3)

Production amount in skidding system and costs

The amount of wood loaded to the depot in time unit, is the amount of production, which calculated by dividing the total volume of the bins transported to the depot by skid machines during the operation. The basis for calculating prices based on the price of skidder and other supplies in 2017. The number of working days is 269 days a year, the useful working time is 4 hours a day, the planned work time is 7 hours per day, the 12% inflation rate and the useful life of the machine (skidder) is 25 years, the coefficient of productivity is 17.44%, and the factor of repair cost is 0.9. The cost of the system includes fixed costs, variable cost and labor costs. The total cost of skidding personnel, which includes one skater driver and one person, is included in the calculations (figure 1& 2).

Timberjack Skid cost (MRH)

Useful working hours (Rial) MRH / PH = 407236

Planned work during working hours (Rial) MRH / SH = 378817

Hourly Labor Costs (LC)

It is calculated by the annual costs of the driver of the skidder and the assistant, which includes all the wages and all the benefits and costs of the overhead (insurance, etc.).

$$567130 = LC = \frac{TLC}{PH} \quad \text{Rial per hour}$$

System Cost (TC)

TC = LC + MRH

Useful working hours (Rail) TC / PH = 974366

Planned work during working hours (Rial) TC / SH = 945947

Skidding cost

Including delay time

974366/11= 88579 Cubic meter / Rial

Without counting the delay time

974366/12= 81197 Cubic meter / Rial

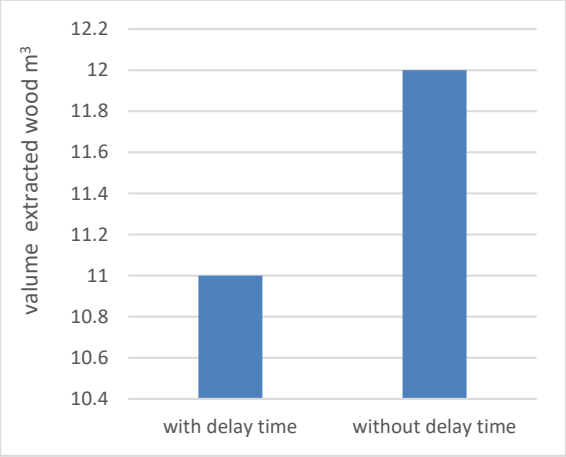

Figure 1: production per hour in extraction stage

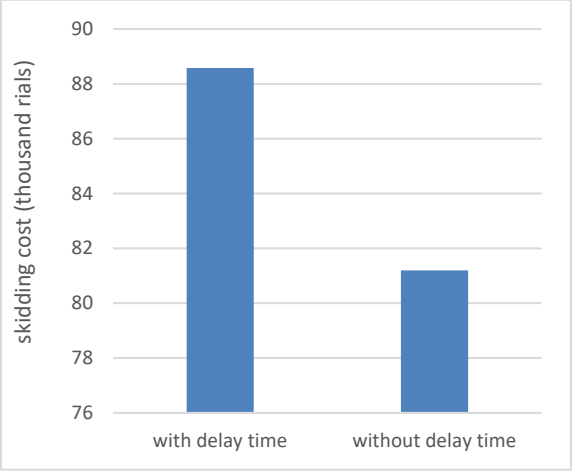

Figure 2: skidding cost per m^3 in extraction stage

The aim of this study was to evaluate the production and cost of exploitation by using the whole trunk method in west of Guilan Province. We tried to provide a mathematical model for forecasting transport time and also to determine the effective variables transport and its role in increasing or reduction of costs per cubic meter of planning (necessary budget, labor and machinery) was an effective step. The importance of this issue in the northern region is due to the lack of a similar study in relation to the assessment of production and cost in the operation of the whole trunk (Naghdi et al 2015). By comparing the efficiency and cost per meter in cube in each of the cut and transport level, the operation can be managed and organized more efficiently to reach the minimum cost and maximum production.

According to a study conducted by Favreau and Gingras, 1998, Pulkki, 2004, Andersson and Eliasson, 2003, Cash (2004), Yousefi Fard (2011), Nikooy et al (2013) on performance evaluation of systems, variables such as load size, load volume, number Load, path length are the important factors affecting the efficiency and cost of the operation system. In this study, the number of trunk, skidding distance were the most important factors were also determined in exiting component. Transport cost analysis showed that with regard to the price of production in the market it has the economical value of supply to the market. Due to the small diameter of the trees, it is necessary to reduce the cost of the unit by increasing the number of trees per skidding, due to the high strength of the skidder of the Timberjack 450c and the ability to transport a large volume of logs that require the production of load have a more number of trees that the skidder could work with maximum power and with the full load of the cutoff direction to the depot.

References

Bagheri, I, Naghdi, R. 2009. Efficiency evaluation of ground skidding system and determining the optimum forest road density in Caspian forest (Northern Iran). International Journal of Natural and Engineering Sciences 3(3): 74-80.

Björheden, R., 1991. Basic time concepts for international comparisons of time study reports. Journal of Forest Engineering 2(2): 33-39.

Favreau, J. and Gingras, F. (1998). An analysis of harvesting costs in eastern Canada. Special report No. SR-129. 10pp.

Ghaffariyan, M, Naghdi, R, Ghajar, I and Nikooy, M. 2012. Time Prediction Models and Cost Evaluation of Cut-To-Length (CTL) Harvesting Method in a Mountainous Forest. Small-scale Forestry. DOI 10.1007/s11842-012-9204-4.

Gonzáles, D.D.J., 2005. A time study and description of the work methods for the field work in the National Inventory of Landscapes in Sweden. Department of Forest Resource Management and Geomatics, SLU. Arbetsrapport/Sveriges lantbruksuniversitet, Institutionen för skoglig resurshushållning och geomatik, Vol. 140.

Hardwood Stands.USDA, Forest Service. Research paper NE-715.

Ledoux, B. and K. Huyler, (2001).Cost Comparisons for three Harvesting Systems Operating in Northern

Lotfalian, M. (2001).Study of Effective Factors in Determining Optimum Forest Road Density in Sangdeh-Mazandaran. PhD thesis, College of Natural Resources, University of Tehran, Iran, 116 p.

Naghdi, R and Ghajar, I. 2012. Application of Artificial Neural Network in the Modeling of Skidding Time Prediction. Advanced materials research (AMR)- 403-408 (2012) pp 3538-3543.

Naghdi, R. N.Rafatnia, H.Sobhani, G.H.Jalali, and S.M. Hosseini, (2005). A Survey of the Efficiency of Timber Jack 450C Wheeled Skidder in Sheared Forests. Journal of Natural Resources, University of Tehran, Iran, 57(4)657-687.

Naghdi, R., Ghajar, I. and Tsioras, P. 2015. Time prediction models of grapple skidder HSM 904 using multiple linear regressions (MLR) and adaptive neuro-fuzzy inference system (ANFIS). Operational Research. DOI 10.1007/s12351-015-0210-0.

Nikooy, M, Esmailnezhad, A and Naghdi, R. 2013. Productivity and cost analysis of skidding with Timberjack 450C in forest plantations in Shafaroud watershed, Iran. Journal of Forest Science, 59(7): 261–266.

Ovaskainen H., Uusitalo J., Väätäinen K., 2009. Characteristics and Significance of a Harvester operators working technique in thinning. International Journal of Forest Engineering 15 (2): 67-77.

Samset, I., 1990. Some observations on time and performance studies in forestry. Meddelelser fra Norsk institute for skogforskning 43(5): 80 p.

Sarikhani, N. (1990).Forest harvesting. 2nd ed. University of Tehran, Iran, 780 p.